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ABSTRACT

Visitors to a public museum were asked to study a museum exhibit and to answer programed questions using a punchboard coordinated with an audio cassette. The audio portion pointed out relationships in the exhibit and directed a visitor's attention, as well as confirmed his answers to the punchboard questions. Some visitors used the audio cassette alone, and some just viewed the exhibit. The effectiveness of these devices was evaluated by means of pre- and posttests given on a gamelike test machine. One unexpected result was that while the cassette punchboard system improved learning, so did simply taking a pretest before viewing the exhibit. This result led to the development and pilot testing of a "recycling" system which uses a gamelike, self-quiz machine that provides criterion questions to help the player identify the concepts to be learned, scores his performance, and gives a free-play token for a good performance. The positive results gained from the use of these interactive devices supports the idea that substantive learning can occur in a public museum. Results also suggest several possibilities for using programed, interactive systems to evaluate and to improve the learning potential of museum exhibits and other public displays. (JY)

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THE APPLICATION OF PROGRAMMED LEARNING AND TEACHING SYSTEMS PROCEDURES FOR INSTRUCTION IN A MUSEUM ENVIRONMENT

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Department of Psychology
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Milwaukee, Wisconsin 53211

December, 1967

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A special statement of appreciation and recognition is due to the late Dr. Stephen deBorhegyi, former Director of the Milwaukee Public Museum, killed in an automobile accident in 1969. Dr. Borhegyi's strong interests in museum visitor behaviors and the museum as an educational environment played a major role in stimulating the writer to formulate this proposal. Dr. Borhegyi played an active part in helping to prepare the original proposal and in its subsequent implementation. It is doubtful if the work would have occurred at all without his help and encouragement.

The staff of the Milwaukee Public Museum, its education department, and many curators were most helpful throughout the project and contributed their time and skills in helping to define exhibit objectives, examine test questions, etc. Special thanks are due Mr. Wallace MacBrier, Assistant Director of the Museum, for his constant support and understanding in tolerating the many deviations in Museum procedures necessitated by the experimental work, and to Mr. Leo Johnson, of the Photography Department, for his continuous and willing help in preparing the many photos and other materials used throughout the project.

SUMMARY

The project to be reported here concerned the possibility that public settings, such as museums, might serve as places in which substantive learning can take place. The learner in the museum is voluntary and usually uninterested in spending the time and effort for serious educational ends. The project in investigated some adaptations of response feedback devices, programmed learning, and a systems approach to exhibit analysis to determine if such methods would facilitate learning in the open learning environment of the public museum.

The project was conducted in the Milwaukee Public Museum with voluntary visitors, 10 years of age and older (median age about 14½) representing a wide range of socioeconomic and educational backgrounds. Experimental exhibits were left unaltered and the attention of the visitor was controlled by the use of individualized audio cassettes, a punchboard response device, and game-like testing and quiz machines. Experimental exhibit areas included a physical anthropology exhibit on five primitive skulls, a religion exhibit on animism and shamanism, exhibits on evolution, heredity, and others.

In one series of investigations, the visitor studied the exhibit while using a punchboard to answer programmed questions coordinated with an audio cassette. The audio pointed out relationships, directed attention and confirmed answers to the punchboard questions. Some studies used the audio cassette alone, or just the exhibit by itself. Effectiveness was evaluated in terms of pre and posttests given, without feedback, on game-like test machines.

Results indicated that (1) both audio with punchboard and audio alone were equally very effective in facilitating learning with about 40% of the participants obtaining 92 - 100% posttest scores; (2) taking a (no feedback) pretest prior to studying the exhibit facilitated learning from the exhibit without supportive aids; (3) little or no learning took place from studying the exhibit alone if no such pretest was given; (4) the posttest performance which was obtained from these conditions was maintained on posttests given 2 and 16 days later; (5) the audio cassette and punchboard system was more effective in attracting younger (below 18) visitors to participate than it was in attracting older visitors (only about 25% of the participants were over 18).

The possibility of using the pretesting experience to facilitate learning from the unprogrammed, unguided exhibit, led to the development and pilot testing of a "recycling" system which used a game-like self-quiz machine which scored the player's

performance and payed off free-play tokens for good performance and a special prize for mastery level performance. The exhibit still served as the primary source of information, while the quiz machine provided criterion questions to help the player identify the concepts to be learned and motivate him to make repeated visits to the exhibit to improve his quiz score. A pilot test of the system showed that (1) visitors did play the quiz machine and represented a wider age range than the audio-punchboard participants; (2) at least half of the observed sample visited the exhibit (recycled) before returning to replay with their free-play token, (3) some players ultimately achieved mastery through "recycling", apparently because the correctional feedback features of this machine made it a teaching machine in its own right. While encouraging, these results indicate the need to remove many, if not all feedback to individual questions, keeping the replay tokens and prize to motivate return to the machine.

The project as a whole supports the idea that substantive learning can occur in the public museum and that museum exhibits are subject to the same kind of evaluation as any would-be instructional or communication system. But, it suggests that, for public access learning, some sort of control over visitor observing behaviors in relation to specific learning goals is needed. The project was not able to investigate the many different ways that this could be done, but five approaches to responsive systems within the museum environment were discussed: (1) the use of individualized programmed audio-cassette tapes and/or responsive question-answering devices coordinated with existing exhibits for specific instructional objectives; (2) self-quiz (recycling) machines in an exhibit area to help the visitor process exhibit information by himself using performance-contingent free-play tokens or some other motivational method to encourage repeated effort; (3) public-access audio-visual "teaching machines" or small computers placed within exhibit areas to supplement the exhibit's ideas using short sections of existing off-the-shelf programs adapted for the public-access devices; (4) interactive displays using small computer terminals or some other response and feedback system and programmed to achieve individualized instructional goals within the framework of the museum's exhibits, including the development of abilities for inquiry, investigation and evaluation.

While the project has not provided working models for all of these alternatives, it has, we believe, raised the possibilities for their development.

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I. INTRODUCTION

The museum, in addition to its curatorial and scholarly functions, is also a learning environment. As a learning environment, museums provide an alternative place for something called "education" to take place (Lee, 1968, Screven, 1969, 1970).

The museum as a place for education may have some unique advantages over more formalized public education for persons of all types and ages. The museum is an open learning environment which, potentially at least, is an exciting alternative to the conventional, restrictive classroom. Museums have no classrooms, no coercive forces, and no grades. The museum visitor is in an exploratory situation, able to move about at his own pace and on his own terms. Unlike formal schools, the museum is basically a "nonword" environment filled with "things" and experience presented in real-life proportions. In sharp contrast to public schools as now constituted, the museum is an ideal place for the practicing of investigatory behaviors, where the visitor is free to choose his own topics for investigation and discover the consequences of his own decisions and inquiries.

Unfortunately, little is known about the museum visitor what happens to him, or how to go about helping him relate to museum resources and learn from them. Museum people have strong beliefs that something is happening, but they have great difficulty defining exactly what this is, much less measuring it.

Museums do generate a good deal of exploratory behavior, but "contacts" with any exhibit topic are brief (less than 40 seconds on the average) and hardly sufficient for substantive learning. Some would argue that cognitive learning is not an objective of museum exhibits--that exhibits are designed more to change "beliefs," "aesthetic sensitivity," "interests," "perspectives," etc., and not to develop substantive knowledge of facts. But, whether or not museum objectives are cognitive or not, little is known concerning the nature of whatever changes do take place, their direction, their retention, who is affected, or how frequently. What changes do take place, apparently, are uncontrolled, random and for the most part unknown.

Many of the features which give museums their appeal as open learning environments pose serious problems both for measurement and for effective communication. For example, the typical museum audience

(a) is heterogeneous in age, background, interests and reasons for being in the museum;

(b) is voluntary (except for visiting school groups) and not necessarily ready to devote time and effort for educational ends;

(c) must be reached while freely moving (often hurrying) along hallways; while visitors are free to stop, look and listen, they are also free to ignore the relevant and attend to the irrelevant;

(d) has no particular instructional objectives on which to base his museum explorations.

To make matters worse, the visitor's relation to the display usually is a one-way affair in which the display remains passive. Whatever the visitor may "do" in relation to what he sees is spontaneous, not necessarily related to the subject-matter, and often incorrect. What is observed, if anything, is left uncorrected by feedback and unrewarded if correct. Within displays themselves, it is difficult to control the order with which the visitor will view materials. Therefore, it is difficult to develop concepts which build upon one another.

Almost all museum displays are put together by curators, artists, and other specialists with primary attention to accuracy, eye appeal, and so forth, but with little if any attention to whether visitors respond to displays in ways that are related to their instructional objectives. Worse yet, most exhibits are put together without specific learning outcomes in mind. Without a clear definition of such instructional or communication objectives, or ways of measuring visitor performance, there is no basis for evaluating existing displays or designing future ones.

Developments in the psychology of learning and motivation in recent years (Skinner, 1966, 1968, Glaser & Reynolds, 1964) suggest that there is much that could be done to correct these deficiencies through the use of self-testing guidance systems, tape cassettes, interactive displays, etc. The use of programmed instruction principles, interactive electronic devices, and automated testing devices could do much to help the visitor utilize the potentials of the museum as an open, free-access learning environment.

The research reported here has attempted to explore some of these possibilities. These empirical studies of museum visitors have included the use of visitor testing devices, programmed materials, the effects of individual audio-visual guidance systems on visitor learning, and strategies for motivating visitors to devote time and effort to educational ends.

In cooperation with the Milwaukee Public Museum, the project officially began in March, 1967 and, after extensions, was completed in May, 1970. The project was not intended to develop instructional programs for exhibits in the Milwaukee Public Museum, but to examine and evaluate systems which could be used with existing exhibits. Emphasis was on methods for programming the visitor, rather than programming the physical exhibit itself. Therefore, in the work reported here, the exhibits were left as is, although the principles of programmed learning which were used could be applied to the design of the physical exhibits themselves which could be made responsive to answers to questions by the viewers.

Brief History of the Project.

The project was officially funded in March, 1967 and was to continue for two years through February, 1969. Two extensions of time were obtained which carried the project to May 31, 1970. While the grant contract was with the University of Wisconsin-Milwaukee, a close working relationship was established with the Milwaukee Public Museum and its Director, Dr. Stephen D. Borhegyi. Much of the work was conducted on the premises of the Milwaukee Public Museum.

The first year of the project was spent securing qualified personnel, exploring exhibits and possible instructional objectives related to these exhibits which could form a basis for testing individual systems. Many of these instructional objectives covered large subject-matter areas and were eventually narrowed down to the limited sets of objectives used at various stages of the project. The two main areas used for the most important studies were (1) the Age of Man exhibit and concerned discriminations between various skulls of Primitive Man, and (2) a secular section of an exhibit on Religion concerning animism and shamanism. Other exhibit areas involved in satellite studies were displays on Evolution and Heredity.

Early work centered around the Age of Man (skull) exhibit and related objectives. This developmental work explored various testing procedures, devices, programming methods, and motivational procedures which eventually led to the equipment and procedures described in later sections of this Report.

The final six months of the project were spent developing several leads provided by the earlier studies, especially in the development and design of a "recycling system," intended to facilitate learning by visitors through game-like self-testing machines. Other final efforts concerned finalizing some of the equipment for regular use on the floor of the Milwaukee Public Museum and for other museum applications.

Some of the results of the studies and their implications have been the basis for several published reports to date (Screven, 1969, 1970a, 1970b, 1970c) and were the subject of a number of conferences and forums on museum evaluation and educational innovation, notably the Smithsonian Forum on Museum Education held in Washington, D.C. in January, 1969 and the Belmont Conference on Museum Contributions to Pre-Science Education sponsored by the National Science Foundation and the Smithsonian Institution, January 26-27, 1970.

The necessary testing and teaching-learning units for use in the museum environment have been finalized and are either on hand or in the process of being delivered. These materials are being used to extend the research reported here, which will be continued on a regular basis at the Milwaukee Public Museum and other museums. The equipment includes automatic start-stop audio cassette units, punchboard question-answer units, two pretest-posttest machines, two coin-token question machines for use in recycling systems, two mobile audio-visual teaching machines with response recorders, and an interactive public access machine for research on feedback and reinforcement variables. As the result of the project, data will continue to be collected on a regular basis in two public museums in the Milwaukee area: the Milwaukee Public Museum and the Milwaukee Art Center in cooperation with the Department of Psychology at the University of Wisconsin-Milwaukee.

II. METHODS

Briefly, the chief goal of the project was to develop public access "learning systems" for use by the voluntary museum visitor which would capture and direct his attention to exhibits, and provide the kind of guidance and feedback which would facilitage learning.

The basic components of the system eventually used are shown in Figure 1.

Figure 1.

The visitor first approaches (voluntarily) a free standing, gamelike test machine and, in the process of playing it, answers a set of criterion questions reflecting the instructional goals of the particular exhibit system. He then proceeds to the exhibit where he is exposed to the exhibit learning system being evaluated. In this project, the learning system consisted of from one to three of the three components shown in Figure 1, as follows:

(1) the physical exhibit itself (which in this project was left unaltered;

(2) an individualized audio-cassette unit, worn by the visitor, and used to direct his attention to relevant details and relations in the exhibit and provide conceptual background; and

(3) a portable punchboard question-feedback device on which the visitor could respond to leading questions —and obtain immediate corrective feedback.

Following exposure to the exhibit system, the visitor returns to the test machine for a posttest involving the same set of criterion questions. (These criterion questions were also available in booklet form which were used in some studies to be described later.)

The audio-cassette was a Norelco cassette "Carrycorder" worn by the visitor over the shoulder and listened to with earphones. A special solid-state circuit, designed and produced by the project's staff for use with the single-channel Norelco unit enabled the tape to be stopped automatically by a beep-tone recorded on the cassette tape. (See Appendix A for a diagram of this start-stop circuit.) Thus, if the visitor is to answer a question, the tape stops automatically. When plugged into the punchboard-question unit, the tape restarts automatically by a correct-answer signal from the punchboard. The tape does not advance on wrong answers.[1]

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[1] See Note #1 in Appendix B. Throughout the rest of this Report, numbers refer to one of the notes in the General Notes section listed in Appendix B. The reader should refer to Appendix B and to the numbered note involved.

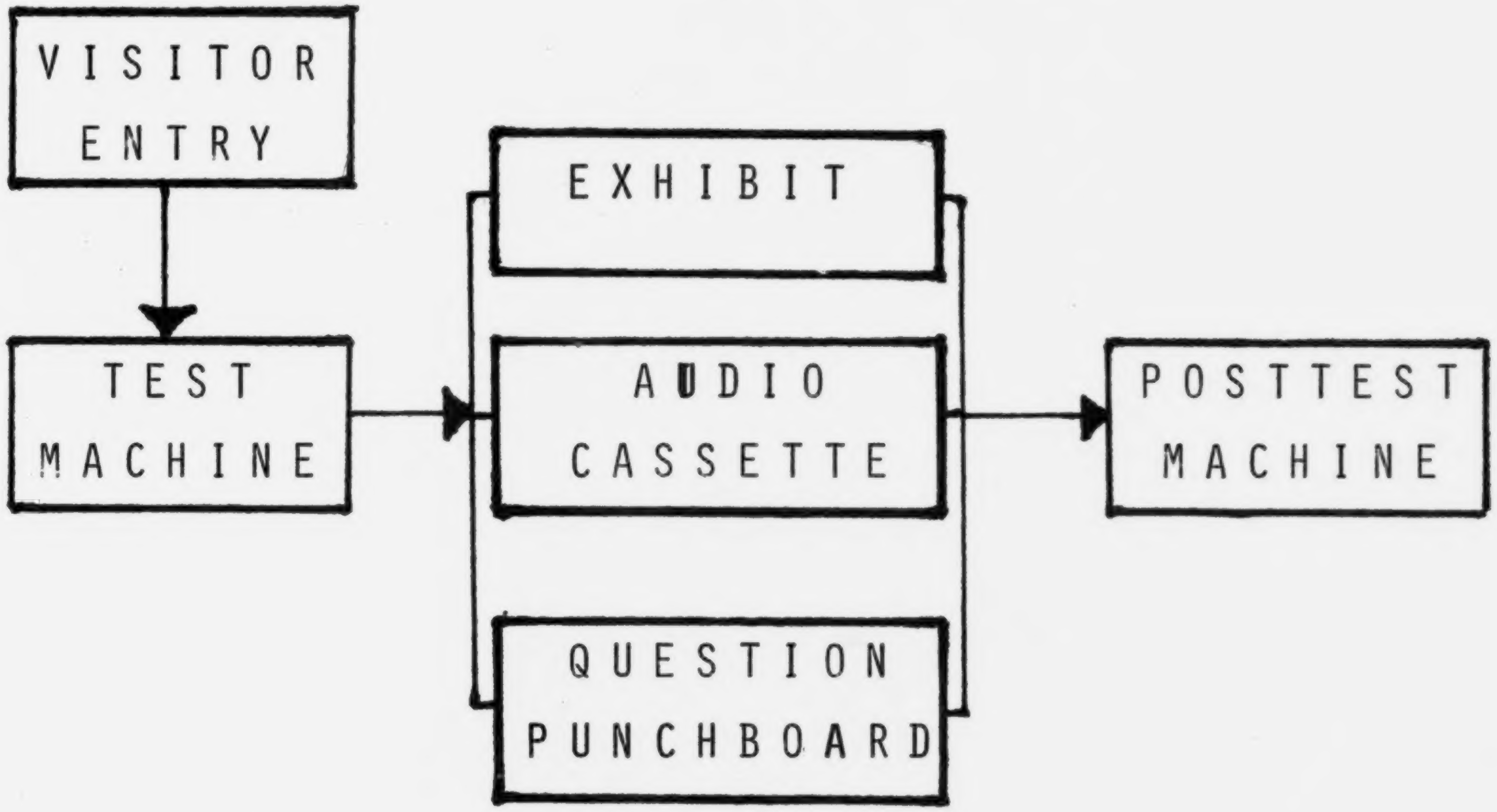
VISITOR ENTRY
TEST MACHINE
EXHIBIT
AUDIO CASSETTE
QUESTION PUNCHBOARD
POSTTEST MACHINE

Figure 1. Schematic diagram of the basic components of the testing and learning system used at the test exhibits.

The punchboard unit is shown, along with the cassette and earphones, in Figures 2a and 2b, with and without a question sheet. The punchboard is designed for use with the cassette and is powered by the Norelco's 6 volt battery power supply when connected to the Norelco's mike-remote-control plug. No modifications are required on the Norelco itself.

Figures 2a and 2b

Question sheets are placed onto the face of the punchboard as shown in Figure 2b. One or more 5 x 7 sheets of questions may be used. Questions are answered by punching holes with the attached stylus. The stylus makes contact with one of the two underlying circuits providing the right-wrong logic of the device. A copper surfaced Key with holes punched for correct answer locations is inserted between the upper punchboard and the lower "correct" circuit. Stylus contact with the upper surface of the Key activates the "wrong" circuit; stylus contact through one of the holes in the Key provides contact with the lower "correct" circuit and reactivates the tape cassette and any other events to be associated with correct responses. Each answer also makes a hole in the paper question sheet and provides a permanent record of all responses for later analysis. If a second and third question sheet are used, these are simply placed over each other in succession.

Activating the "correct" circuit automatically restarts audio cassette (after it has stopped for a question) and in normal use briefly lights a small display of lights on the front panel (see Figure 2b) as a further signal that a correct response has been made.

Figure 3 shows the cassette and punchboard devices being used by a visitor at the Age of Man exhibit. The punchboard was small and light enough (2 x 6 x 9 in.) to be held by the visitor while using it; however, at the Age of Man exhibit, many visitors took advantage of the open shelf in front of this exhibit as the visitor in Figure 3 was doing.

Figure 3.

The Audio Script

There are, of course, many options in how audio might be used in museum applications. In the present investigations, audio served to direct the visitor's attention to (a) details and relations within the exhibits which were related to the instructional objectives and (b) to specific questions which were designed to "force" the visitor to notice these details. Audio scripts usually consisted of statements about exhibit relationships, where to look, commands to answer questions on the punchboard and, in some cases, to ask questions. (Appendix C shows some of the audio scripts used in later stages of the project.)

When used with the punchboard, the tape was programmed to automatically stop at the end of each segment where a question was to be answered, and, as described earlier, was restarted when a correct answer was obtained. When the cassette was used without the punchboard (audio-only conditions), the question to be answered was asked on the tape followed either by an automatic stop (restarted by the visitor by pressing an attached "advance" button), or by a 5-sec. pause.

The audio that followed a question was accompanied by remarks such as "Good! The skull was Neanderthal", before continuing with the next segment of the script. Thus, the audio scripts served the multiple functions of directing attention, defining important relationships, providing immediate feedback, and providing a verbal "reward" for correct responses. Audio minimized the need for reading labels, helped to control the order in which the visitor examined the exhibit, organized the parts of the exhibit into meaningful relationships, and through feedback, helped to motivate the visitor to continue.[2]

Early audio scripts utilized conversations between several persons and included the visitor as a third party. In one instance, the skulls in the Age of Man exhibit were given voices with appropriate accents, and the style tried to sustain interest through side comments, etc. However, these efforts proved to be unnecessary, even for the younger 10 and 11 year old participants, and led to many comments that the tapes were too wordy, too long, etc. Eventually, our audio scripts used a single (male) voice who confined his statements to simple exposition, to directions needed to answer upcoming questions, and to confirming correct answers.

Programmed Questions.

In the early stages of the Age of Man project, a rather extensive set of instructional objectives were related to over 30 punchboard questions which required three separate pages. Later, these were simplified and reduced to 16 questions on a single sheet, as will be described in more detail in a later section. The shortened version of 16 questions for the Skull program (see Appendix C), along with the accompanying audio, usually took the visitor from 10 to 12 minutes to complete. At the Religion exhibit, a set of 11 questions and accompanying audio also required from 10 to 12 minutes to complete.

The questions were designed to "force" observing responses by the visitor to those aspects of the exhibit related to the instructional objectives. The questions were developed through preliminary tryouts on the punchboard with visitors at the exhibits. Stylus holes provided a record of all visitor responses. Each week's performance was analyzed for errors, etc. Questions on which errors were made, together with the accompanying audio and existing exhibit labels and other features were reviewed for possible ambiguities, errors, inconsistencies, etc. and revised, retested, further revised, etc. until at least 90% of the visitors over three and four week tests obtained at least a 90% score with errors distributed across questions. The final questions and their accompanying audio are listed in Appendix C and will be discussed later.

During developmental testing of the punchboard questions, little difficulty was experienced in obtaining the continued attention of visitors of all ages to the question-answering activity. However, if it was possible to guess at answers without looking at the exhibit, or to deduce likely answers from the wording of the questions themselves, visitors tended to work with the punchboard with little or no attention to the physical exhibit in front of them. Thus, a question such as "Neanderthal's skull is (a) more pointed, (b) less pointed, (c) about the same shape as CroMagnon's skull" would often be answered without looking at the exhibit. To obtain exhibit observing behavior, it was necessary that questions were asked so that the exhibit and the audio were both necessary to determine what question was being asked, as well as its answer.

Pre-Post Testing: Machines and General Procedures.

As described earlier, a separate game-like machine was used to test visitors prior to and following exposure to particular exhibit learning systems. Since visitors were expected to resist taking "tests" while visiting a museum on their own time, it seemed desirable to make the testing situation as attractive as possible. Observations on visitor behavior throughout the museum indicated that they were easily attracted to manipulable free-standing objects with buttons, etc. We therefore attempted to utilize this curiosity and interest in "gadgets" in designing the pre-posttest situation.

Several pre-posttest machines were developed and tested. One such machine is shown in Figure 4 with a visitor answering one of the criterion questions on skulls from the Age of Man exhibit. On this device, 5-choice multiple-choice slides are automatically projected on a large (24 x 36-in.) screen. Five answer buttons are arranged along the base of the screen directly under the choices for each question, as shown in Figure 4. In

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Figure 4.

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order to minimize the role of the pretesting situation as a learning situation, no feedback was given after choosing an answer. After each choice, the next question was presented regardless of the correctness of the choice. Questions were prepared on 2 x 2 slides and projected by an Ectographic Kodak Carrousel (Model AV-303). Upon completion of the sequence of questions, the projector automatically advanced to the beginning of another test sequence and turned off. While not being played, the projector remained off. A floor pad switch in front of the machine turned on the projector when a visitor stood in front of it.[3] The system was housed in a cabinet manufactured by a Milwaukee game machine company.[4] The test machine stood near to the reference exhibit, but not in visual contact with it. A remote IBM card punch machine recorded each answer along with the visitor's code number, age, and educational level.

A second type of pre-posttest machine is shown in Figure 5.

Figure 5.

This was an adaption of an "MTA-400 Stimulus-Programmer" for public-access operation.[5] Test questions were printed on a continuous loop of paper which could be indexed so that questions advanced and stopped one at a time in the viewing window shown in Figure 5. Questions were answered by pressing one of four response buttons shown at the lower left of the machine in Figure 5. As was the case for the slide machine, questions advanced regardless of correctness so that the visitor received no feedback on the correctness of his choices. A foot pad switch activated the system; the visitor received instructions from a telephone (see Figure 5) mounted to the right of the machine played from a Cousino continuous-loop tape player when the visitor picked up the receiver.

Pre and posttests were also prepared in booklet form for comparison with the machine mode of testing and for use with a retention study where follow-up posttesting was done in the home. Each question was prepared on a 8½ x 11 page (protected by acetate), in color, and in a format identical to that used for the same question on the test machines. Responses to booklet questions were made by circling the choice on a separate answer sheet provided by a project staff member.

Visitors who participated in the project's studies were not directly approached by project staff, but became involved in the system after they had approached a pretest machine or the nearby reception table (sometimes because they were interested in the punchboard devices seen being used by other visitors). A sign, "Try Our New Teaching Machine," was located in the pretest-posttest area.

Description of the posttest questions and the procedures used in their development and final selection will be given in a later section in connection with specific studies.

Participants.

Over the total period of the project, over 2,000 different persons were run under various testing and experimental learning conditions. Obtaining data on so many persons within a museum setting turned out to be a slower process than anticipated. We had at first expected that test systems could be set up daily on the museum floor and data collected on each of the 7 days of the week that the museum was open to the public. However, except for summer months and holiday periods, attendance at the museum was too poor during weekdays to justify the small number of subjects obtained. Therefore, much of the data to be reported were obtained on Saturdays and Sundays (between about 11 a.m. and 4 p.m.).

The free-standing test machines shown in Figures 4 and 5, and the punchboard-cassette learning units, did very well in attracting and holding the attention of younger visitors of intermediate and high school ages from a wide range of socio-economic backgrounds. Of the over 1,400 visitors who voluntarily participated in the floor tests of various teaching programs (excluding those whose responses were used to select criterion questions for use in test machines), about 75% were between the ages of 11 and 17 years with from 4 to 12 years of schooling. Approximately 35% were nonwhites. While ages of participants included persons up to 52 years of age and persons with advanced degrees, the median age was about 14.5 years. Adult visitors would readily participate in playing free-standing question machines when they could do so in relative privacy, but were often reluctant to approach staff to obtain the punchboard or cassette units or to commit themselves to the time involved. Advertising special incentives, including cash awards for good test performance, did not improve adult participation.

Visitor participation took place under a wide range of crowded conditions, times of the year, distracting circumstances, and social pressures (arising from peer groups, family resistance, etc.).

Developmental and Exploratory Studies.

Over the period of the project, the pretest-posttest performance of visitors was compared under a variety of exhibit learning conditions with different types of audio, complexity and length of material to be learned, and different motivational conditions. Early exploratory work tried different kinds of visitor response systems, prototype models of question-answer devices, different styles of audio, and a variety of programs based on different lists of instructional objectives.

During the earlier stages of the project, we underestimated the visitor's ability and interest in devoting time and effort to the learning materials in order to achieve correct answers to their punchboard questions. In anticipation of such difficulties, a series of preliminary tests were run in which visitors were offered cash incentives for achieving a high score on their posttest after going through the Age of Man (Skull) exhibit. Incentives were offered ranging from 25¢ to $4.00 for achieving 6 out of 7 questions correct on the Age of Man Posttest then in use. No significant differences were found among various monetary levels. Posttest performance of those visitors who were offered money did somewhat better than visitors offered nothing.[6] Interpretation of the results was somewhat difficult because the programmed audio-question materials were undergoing changes during this period and the pre-posttest questions later proved to have ambiguities.

In line with our concern over the need for extrinsic visitor motivations, a second type of punchboard device was developed and tested. Instead of providing feedback in the form of the flashing lights and resumption of the audio, the new device provided an accumulating score in the form of lights. Each correct response on the punchboard cumulated on a 3-light panel and each error cancelled this accumulation; three successive correct answers lit up special score lights on the panel which entitled the visitor to special prizes. Thus, careless guessing at answers would be discouraged because errors would result in loss of accumulated points. However, subsequent studies comparing the use of this system with the simpler punchboard showed no differences in visitor performance either in terms of errors made on punchboard questions or on posttests. Furthermore, use of the cumulative scoring punchboard required an extra pre-exhibit program to teach the visitors the proper use and interpretation of the punchboard's scoring system, which added to the time required.

Continued improvement in the punchboard questions, accompanying audio, and in the criterion test questions used in pre-posttests indicated that most visitors did not need special incentives or scoring devices in order to devote the necessary attention to the exhibit materials. High posttest performance began to emerge as the programmed questions and audio materials improved and the criterion questions used in pre-posttesting were more carefully related to the exhibit learning system and corrected for ambiguities. Therefore, in subsequent investigations, the more elaborate cumulative scoring punchboard system was abandoned in favor of the simple punchboard device described earlier. Furthermore, no special offers were made to visitors for achieving high performance, either on the punchboard questions or on the posttests.

III. EXPERIMENTAL STUDIES

For the purposes of this Report, we shall consider in more detail the procedures and results of six investigations which utilized the criterion test questions, audio scripts and punchboard questions which finally evolved from the earlier exploratory investigations. These studies attempt to evaluate the role of the different components (the exhibit punchboard, audio, and the pretesting experience) in facilitating learning from two experimental test exhibits: the Skull display at the Age of Man exhibit and a display on animism and shamanism in the Hall of Religion. These will be considered in order of their occurrence along with the primary results. Conclusions and discussion of these results as a whole will be given in later sections of this Report.

Development of Criterion Questions: Skull Exhibit.

Development of a final set of criterion questions for use on pre-posttests at the Age of Man exhibit for evaluation of various components in exhibit learning systems was based upon four kinds of behaviors related to the five primitive skull artifacts of the display. These were:

(1) Naming the skull
(2) Matching the proper skull to its name
(3) Ordering the skulls by age
(4) Ordering the names of the skulls by age

Two Kodak Carrousel trays of 160 colored slides were prepared, covering every possible combination and format of the above behaviors. The Automated Slide-Test Machine shown in Figure 4 (described earlier) was set up in a hall area of the museum near (but not at) the Age of Man exhibit. It was connected to a remote IBM card punch which recorded each visitor's response to each question and whether or not the response was correct. No one attended the machine so that each visitor approached and operated the machine on his own. No feedback was given as to the correctness of the responses.

The machine remained on the floor for about 6 weeks. Baseline data were obtained involving over 500 persons on each of the 160 slides. These data were analyzed by an SAP (Statistical Analysis Package) Program which provided a 5 x 160 matrix of choices x slides giving the number of responses on each choice to each slide and percent correct choices for each slide. On the basis of this analysis, all slides were rejected on which there were over 30% correct responses. This reduced the total number of slides by over 50% to less than 80 slides (1 tray).

The remaining slides were then used in the same machine in the same manner with the additional procedure of having observers record remarks made by visitors to the slides and interviewing individual visitors concerning their understanding of particular slides, what they thought was ambiguous, etc.[7] After an additional 3 weeks, during which over 200 more persons completed the materials, the questions were reduced to a total of 20 slides which were unambiguous and still resulted in less than 30% correct answers. These 20 slides were then reduced to a total of 12 slides which represented the minimum number of slides which sampled the four criterion behaviors described earlier. These 12 criterion questions are shown in black and white in Figure 6 in the order in which they were presented. The skulls in the actual slides were in color and closely approximated the artifacts displayed in the exhibit.

Figure 6.

Development of Single-Feature Skull Program.

While these criterion questions were being selected, several exhibit programs were being tested which were designed to develop the four behaviors described earlier for the five skulls. The initial program attempted to teach the visitors to discriminate between the skulls and order them in terms of three criteria: cranial area of the skulls, muscle protrusions (including eye ridges), and the shape of the backs of the skulls. This initial 3-feature program consisted of a total of 24 punchboard questions printed on 3 separate sheets that were placed onto the punchboard successively. Together with the audio, this program took about 25 minutes to complete. Through successive revisions based on punchboard error rate, the 3-page program was revised until it consistently yielded at least 90% correct responding for at least 90% of the participants.

Mean posttest scores for this final 3-page program was a consistent 75% or better on the 12 criterion questions described earlier. However, interviewing participants following the posttest also showed up criticisms--especially, its excessive length. Some visitors simply did not have the necessary 25 minutes (plus pre-posttest time) to devote to the program. Some did not (or could not) finish.

Because of its excessive length, the program was re-examined. It was decided to eliminate the use of muscle protrusions and shape of the back of the skulls as bases for the discriminations and limit discussion to the cranial area as the basis for discriminations. This enabled the audio script and questions to be reduced to a single-page program of 16 questions requiring only 10 to 12 minutes to complete. Mean posttest score for the initial shortened

Figure 6b.

program (n = 75) dropped to about 60% which was lower than our objective of at least 70% mean posttest score. After minor revisions in wording, however, the shortened version finally yielded mean posttest scores of about 75% over four weeks of testing and this version became the program used in the experimental studies described below.

Over 450 museum visitors participated in various stages of the development of the Skull program to this point.

Study 1: Learning Skulls Under Machine, Audio-Only, Exhibit-Only, and No-Pretest Conditions.

This study involved a total of 201 visitors tested over a 10-month period on the 12 criterion questions on Skulls described earlier (Figure 6) and using the shortened single-page version of the teaching program. The subjects ranged from 10 to 30 years of age (Mdn = 14 years) and were in the process of exploring the museum in the area of the Age of Man exhibit. The majority of Ss (about 75%) were between 11 and 17 years with 4 to 12 years of schooling. As in all of the work in the project, all socio-economic groups were represented and approximately 30% were nonwhites.

Experimental Conditions.

Four groups of Ss were run under four exhibit learning conditions. Each of the conditions was run on successive testing days until no less than 48 Ss were obtained for that condition.[7] The four experimental conditions were as follows:

M-Condition (n = 50): Both the punchboard and cassette tape shown in Figure 2 were used to relate the visitor to the exhibit. Each S took the pretest on the test machine shown in Figure 4 without feedback. He was then given the cassette tape and punchboard and sent to the nearby exhibit where he worked on his own under the direction of the audio as described earlier and the punchboard questions described in Appendix C. Upon completion of the programmed questions, S returned to the test machine and retook the 12 posttest questions, again without feedback.

AQ-Condition (n = 51): Only the audio cassette was used, without the punchboard. The 16 questions formerly asked on the punchboard were inserted on the tape in appropriate spots. The S could answer the questions only to himself. Each audio-question was followed by a 5-sec. silence before audio confirmation of the correct answer and continuation of the program.[8] Except for the questions, the audio script was identical to that used under the M-Condition. (See Appendix C for exact modifications of audio-only script.)

E-Condition (n = 51): The exhibit itself was used without either the audio-cassette or the punchboard. The S was left entirely on his own to process whatever information he could from the labels and physical layout of the exhibit, without guidance or feedback. Each S took the pretest as in the other conditions and was then told to go to the exhibit, study it, and then return for a test on the machine.

E (NP) Condition (n = 49): Identical to the E-Condition, except that the S was directed to the exhibit before taking the criterion test on the test machine. Thus, S was exposed to the exhibit without prior knowledge obtained through the pretest about what the instructional objectives might be. This represented the "normal" learning situation for most museum exhibits.

Results: Pre and Posttest Performance.

Pretest Results. A frequency distribution of pretest scores for the 201 Ss tested in Study 1 is shown in Figure 7 along with

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Figure 7.

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the theoretical chance distribution (dotted line) given no knowledge of the test questions whatsoever. These curves show criterion test scores plotted against the percent-visitors obtaining these scores. As may be seen from Figure 7, the pretest distribution is very similar to the chance distribution, showing only a small pre-exhibit knowledge of the skull discriminations involved (skull naming, skull ordering, etc.). The mean pretest score for this group of 201 Ss was 25.2%, about 5% above the theoretical chance score. The pretest distribution curve shown here is very similar to the pretest distributions obtained from the over 450 Ss tested during the development of the programmed materials. This distribution and mean and median scores have proved highly stable across different times of the year, different days of the week, etc.

Posttest Results. Figures 8-11 compare the frequency distributions for each of the four conditions with the pretest performance for the combined group.

Figures 8 - 11.

Figure 8 shows the distribution of posttest scores for Ss (n = 50) exposed to the exhibit under the M-Condition (punchboard and audio cassette). Performance increased sharply over pretest

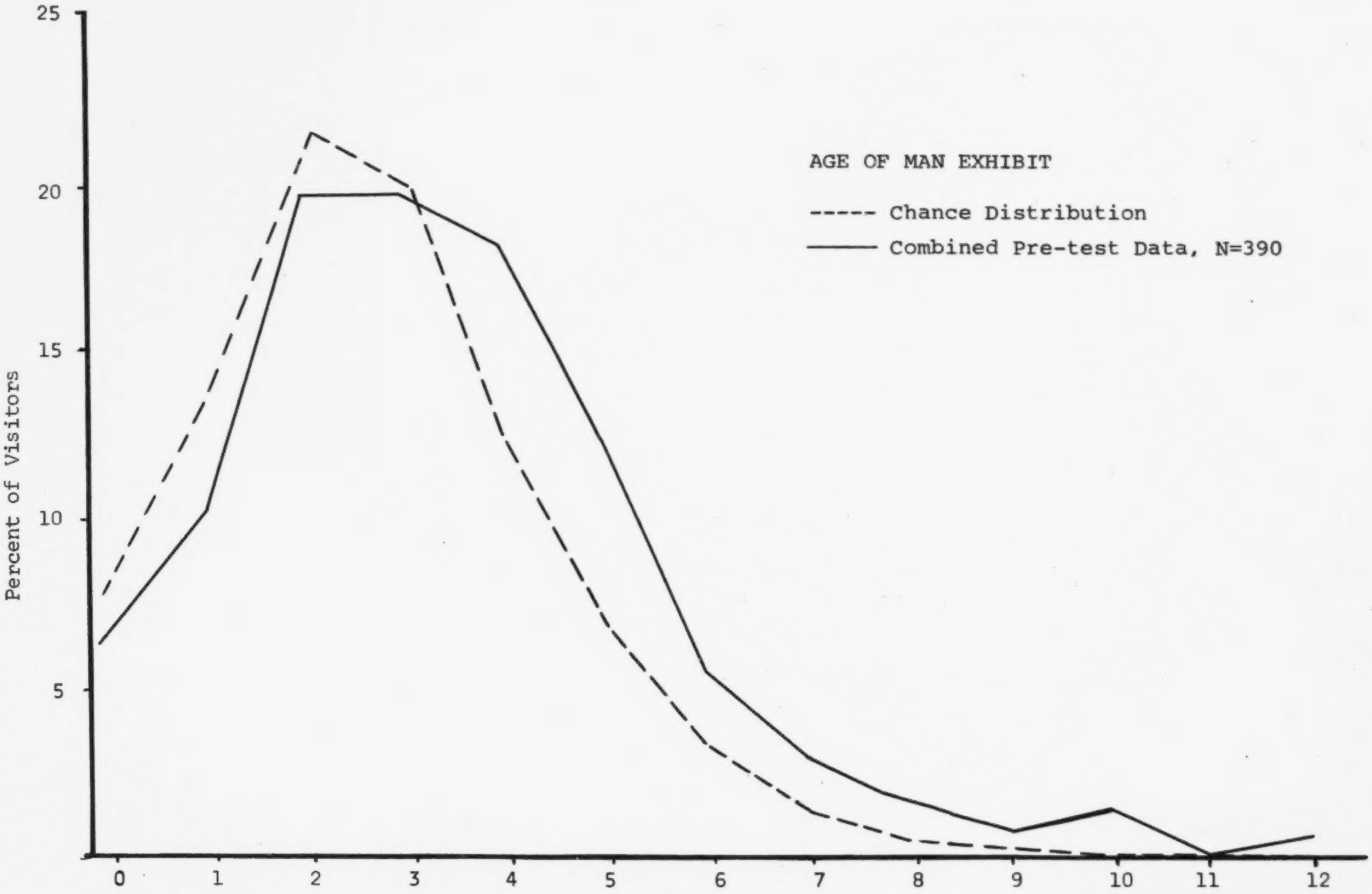

Figure 7. Frequency Distribution of Pretest Scores for Skull Exhibit (n = 201) Compared with Expected Chance Distribution

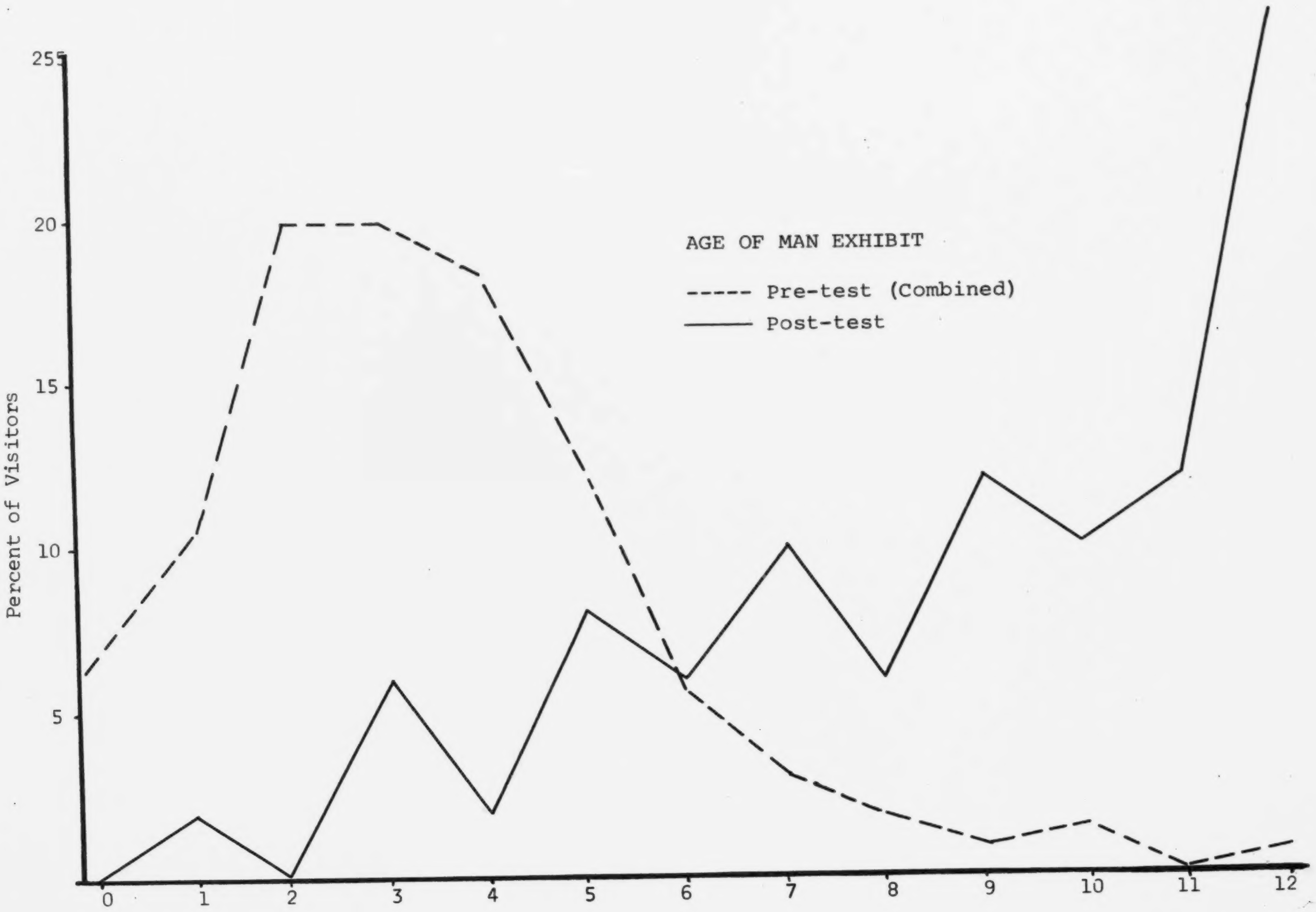

Figure 8. Frequency Distribution of Posttest Scores for M-Condition (n = 50) at Skull Exhibit Compared with Pretest Scores (n = 201)

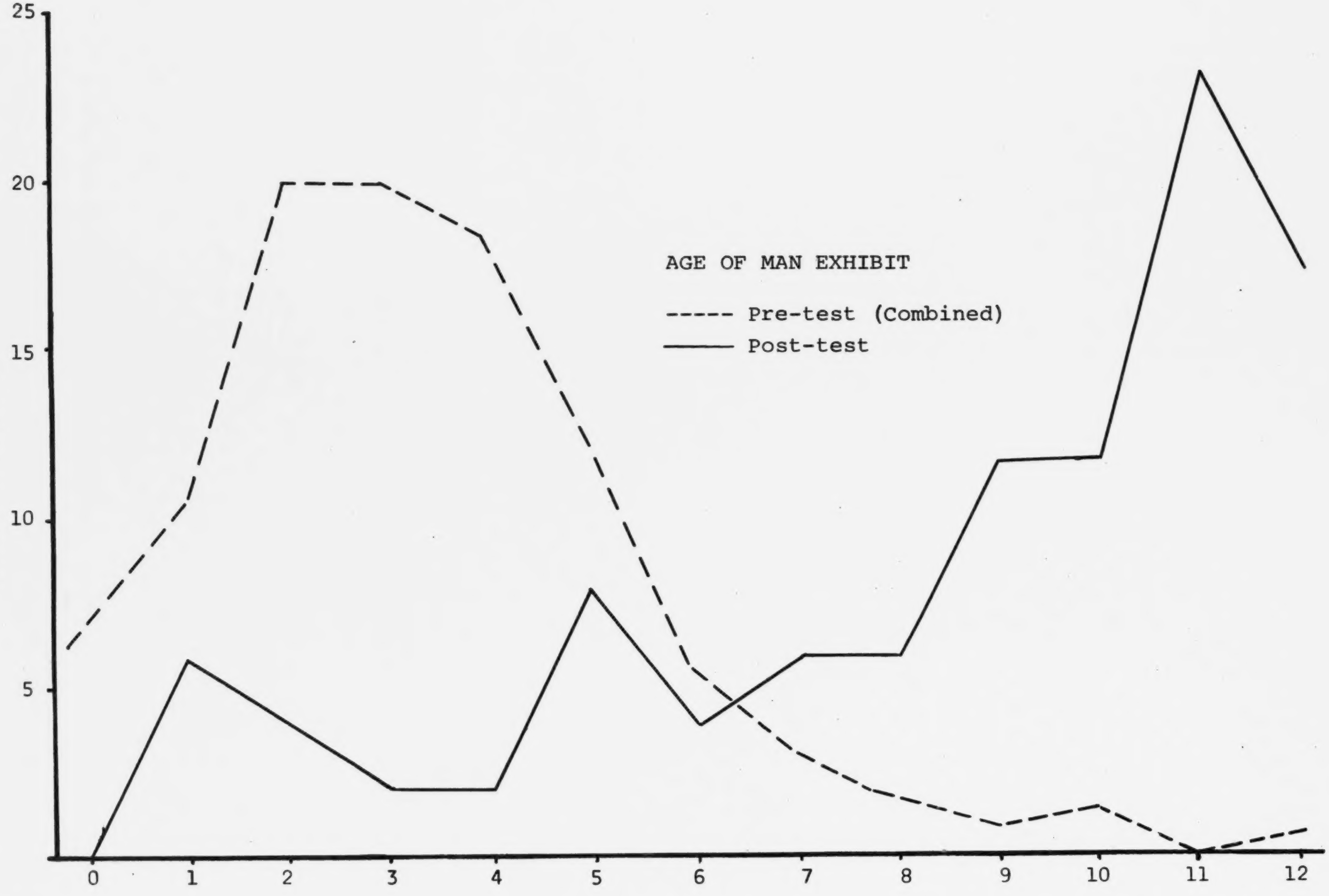

Figure 9. Frequency Distribution of Posttest Scores for AQ-Condition at Skull Exhibit (n = 51) Compared with Pretest Scores (n = 201)

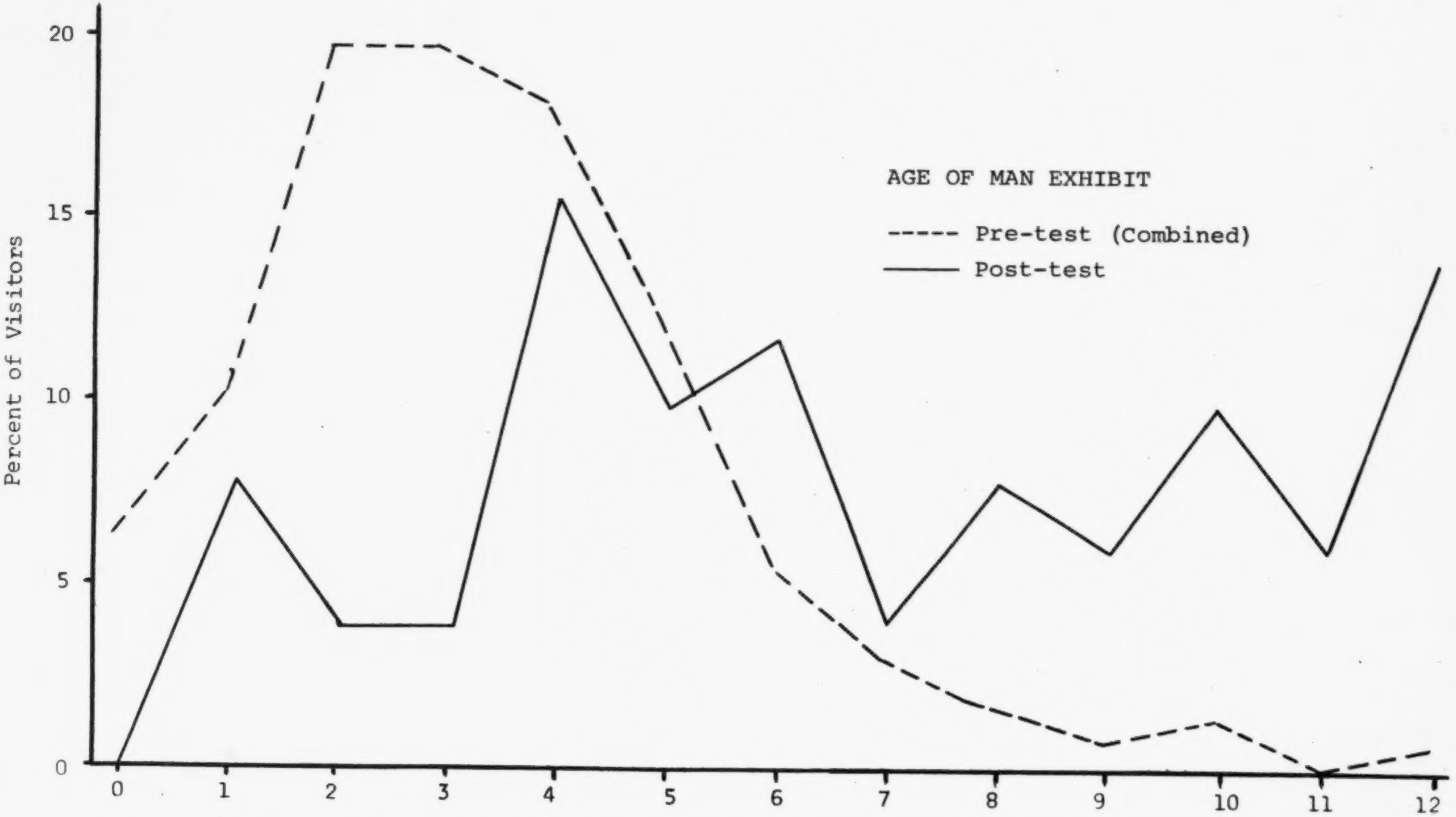

Figure 10. Frequency Distribution of Posttest Scores at Skull Exhibit for E-Condition (n = 51) Compared with Pretest Scores (n = 201)

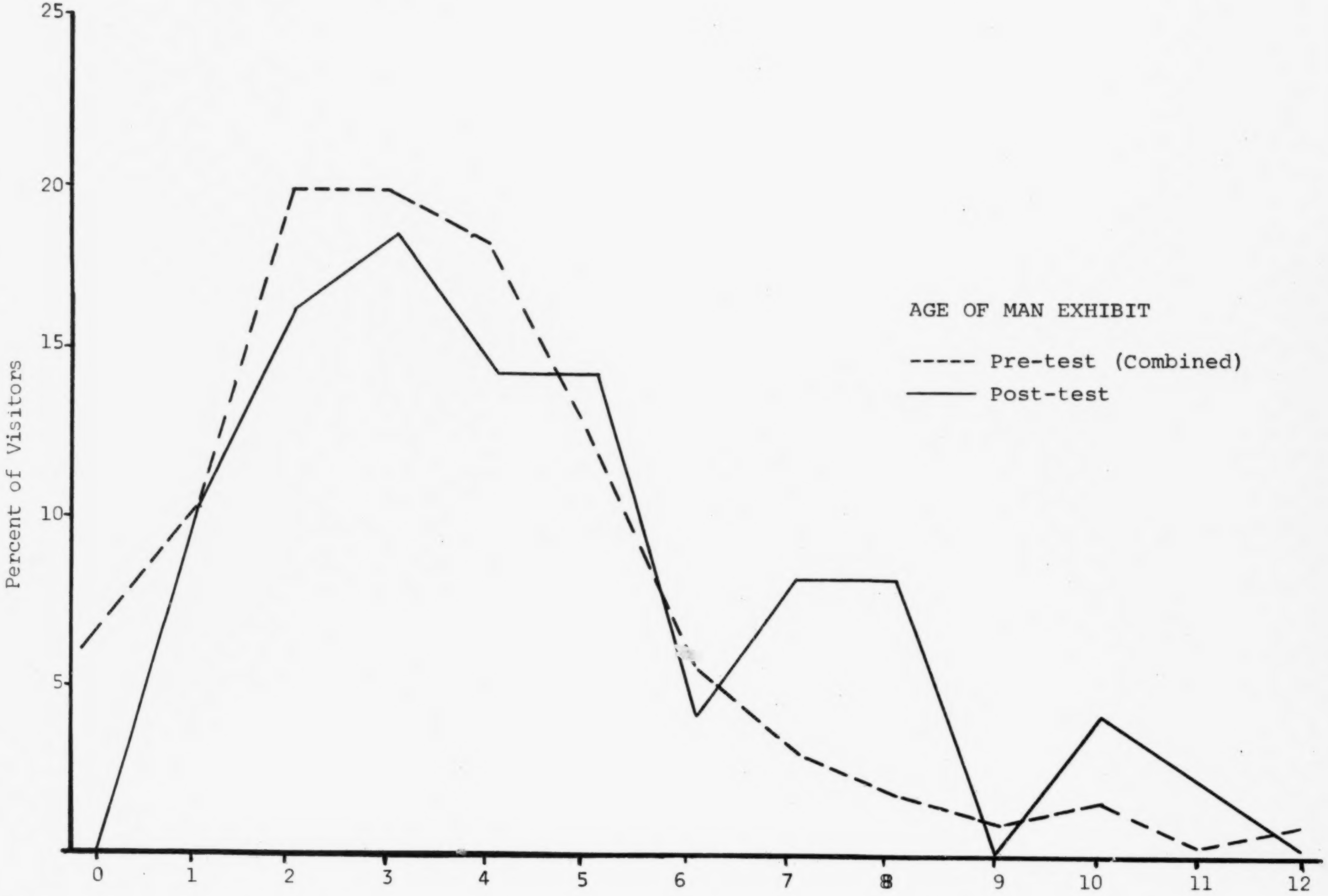

Figure 11. Frequency Distribution of Posttest Scores for E(NP)-Condition at Skull Exhibit (n = 49) Compared with Pretest Scores (n = 201)

performance with over one-third (38%) achieving a 92-100% posttest score. Over one-fourth (26%) received a perfect score. Mean and median performance for the total group were 72.8% and 75% respectively.

Figure 9 shows results for Ss (n = 51) for the AQ Condition (audio-cassette and audio questions only). Performance was similar to the M-Condition (Mean = 71%, Mdn = 79%). Apparently, the availability of an overt response device, such as the punchboard, was not essential in achieving high posttest performance. About 40% of the Ss achieved a 92-100% score. However, it should be noted that the AQ Condition utilized an audio script and audio questions which had previously been tested and developed for minimal error with the punchboard.

Figure 10 shows the results for the E-Condition (n = 51) which involved the exhibit only without audio or punchboard. After taking the pretest, the visitor studied the exhibit without benefit of either the punchboard or audio cassettes. Mean posttest score dropped to 57% (Mdn score dropped to 50%). Some visitors still showed considerable improvement, although not as dramatically as they did under the AQ and M Conditions. About 19% of the visitors obtained the 92-100% level. Although these Ss received no feedback or other knowledge during pretesting of how well they were doing, the pretest experience probably provided important advanced information re instructional objectives which may have helped "process" relevant exhibit information.

The importance of the pretesting experience was substantiated by the results obtained for 49 Ss who studied the exhibit without taking the pretest (E (NP) Condition). Figure 11 shows the results for this group and as may be seen, the distribution of scores closely approximates the distribution of pretest scores (dotted line), with mean and median performance at about 36% and 33% respectively.

An analysis of variance of the four exhibit conditions yielded a between treatment variance significant beyond the .001 level (F = 21.82, d.f. 3/197).(16) Based on this result, a Newman-Keuls analysis of the differences between means (Table 1) showed that while there were no significant differences between the means of Conditions M and AQ (as noted earlier), they were both greater than Condition E ($p < .01$). Condition E, when compared with Condition E (NP), was significantly greater than Condition E (NP) ($p < .01$).

Table 1.

Treatments		E(NP)	E	AQ(w)	M
	Means	4.37	6.80	8.61	8.74
E(NP)	4.37	-	2.43**	4.24**	4.37**
E	6.80		-	1.81**	1.94**
AQ	8.61			-	.13
M	8.74				-

* = $p < .05$

** = $p < .01$

Table 1. Newman-Keuls Analysis of Differences Between Means of the E(NP), E, AQ, and M Conditions at the Skull Program.

Study 2: An Analysis of Audio Conditions.

The results of Study 1 indicated that the use of the audio cassette without the opportunity to overtly respond to questions on the punchboard was equally effective in producing significant improvement in learning for many of the visitors. The AQ condition included a 5-sec. silence following each of the questions, presumably to encourage Ss to take time to answer. This took additional time and we were interested in whether this 5-sec. silence was necessary. Another question was the importance of the questions themselves.

Study 2 concerned a comparison of the AQ and E groups of Study 1 with two additional groups of Ss run under two additional audio conditions:

AQ(w) Condition (n = 51): The same audio script was used as in the AQ Condition, but without the 5-sec. silence following questions:

AN Condition (n = 49): The same audio script was used as in the AQ Condition, but the questions were omitted. Thus, the audio material was presented here in essentially narrative form. (See Appendix C for modifications of audio for AN Condition.) In all other respects, all other conditions were the same.

Results. The data from these two additional groups were included in a four group comparison with the AQ and E groups from Study 1--that is, three audio conditions with the no audio condition. The mean posttest scores of the four groups, E, AN, AQ, and AQ(w) were 6.80, 7.73, 8.33, and 8.61 respectively. An analysis of variance yielded a between-treatments variance which was significant beyond the .05 level (F = 2.92, d.f. = 3/199). A Newman-Keuls analysis (Table 2) showed (as expected) that there were no differences between AQ and AQ(w) and that the E condition did not differ significantly from the AN condition, while the audio conditions involving questions (AQ and AQ(w)) were both significantly greater than no audio at all (E-Condition).

Table 2.

Study 3: Effectiveness of Different Pre-Exhibit Treatments on Learning From the Exhibit-Alone (E-Condition.

From Study 1, results indicated (groups E and E(NP)) that the pre-testing experience played a role in helping some visitors achieve high posttest scores after studying the exhibit without qudio or questions. Although no feedback was given during pretesting, the pretest experience for group E apparently helped

Treatments		E	E(N)	AQ	AQ(w)
	Means	6.80	7.73	8.33	8.61
E	6.80	-	.93	1.53*	1.81*
E(N)	7.73		-	.60	.87
AQ	8.83			-	.28
AQ(w)	8.61				-

* = $p < .05$

** = $p < .01$

Table 2. Newman-Keuls Analysis of Differences Between Means of the E, E(N), AQ, and AQ(w) Conditions at the Skull Exhibit.

define for some Ss some of the objectives for studying the exhibit which in turn may have helped them to process exhibit information relevant to the posttest. We were interested in whether this same result could be obtained by giving the visitor, prior to studying the exhibit, a printed statement of what to look for without giving a pretest. Another question concerned the effects of taking the pretest in booklet form instead of by machine.

Study 3 concerned a comparison of the E(NP) and E conditions of Study 1 with two additional groups of Ss tested after studying the exhibit on their own without audio under the following conditions, along with the pretest performance of these groups.

E(I) Condition (n = 53): This was like the E condition, except that instead of taking a pretest, all Ss received a 5 x 7 card with a typed summary of what to look for in the exhibit. The card read as follows:

> Notice the skulls in the exhibit with large white letters over their heads. Skull A is Modern Man, and Skull B is Neanderthal Man. Look closely at the five skulls in the exhibit and try to do the following:
>
> 1. Find the scientific names of skulls C, D and E. The scientific names of each of these skulls is in small white letters near the top of the panel under "EARLIEST MAN," "NEAR MAN," and "EARLY MAN APE."
> 2. Name each of the five skulls when shown his picture.
> 3. Recognize the picture of each skull by name.
> 4. Know the order of the five skulls from oldest to most recent, both by pictures and by name.

Ss carried this card with them to the exhibit. Following the exhibit, they returned to take the regular posttest by machine.

E(B) Condition (n = 51): Same as condition E in Study 1, except that Ss took the pretest from a looseleaf booklet in which each of the 12 criterion questions was presented in identical format as described earlier. Questions were answered on a separate answer sheet and were administered by a project staff member. No feedback was given and no conversation took place between visitor and staff member during testing.

Results. The data from these two additional groups were included in a five group comparison with the E and E(NP) groups from Study 1 and the pretest scores represented by these five groups.

An analysis of variance of these five groups yielded a between-treatment variance significant beyond the .01 level (F = 11.25, d.f., 4/250). A Newman-Keuls analysis of the differences between means (Table 3) indicated no significant differences among the three pretest conditions (E, E(I) and E(B)), but significant differences between all of these three conditions and the E(NP) condition as well as the pretest baseline performance.

Table 3.

Study 4: Retention Over 2 and 16 Days.

The delay between exposure to the exhibit system and starting the posttest averaged about 2 minutes. To obtain information concerning retention of the exhibit information over longer periods, Study 4 was conducted with a separate group of 67 Ss. This was a completely separate study which replicated the procedures and the three exhibit learning conditions M, AQ(w), and E. The exhibit condition was followed by the usual machine posttest, followed by two additional test sessions, approximately 2 days and 16 days later. Addresses and phones were obtained at the end of the first posttest session when visitors were told that they would be given the questions again at their homes. For the second and third tests in the home, the booklet form of the test (described earlier) was used. As in the case of Study 1, no feedback or other knowledge of results were given to Ss during any of the three posttests.

Of the original 67 visitors who completed the initial programs at the museum, 43 completed both the second and third posttest sessions.

Figure 12 shows the mean pretest (combined) and posttest performance for each of the three posttest sessions for groups M (n = 12), AQ(w) (n = 16) and E (n = 15). As is apparent from

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Figure 12.

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these curves, visitor performance was maintained over the 2 and 16 day period at essentially the same levels as obtained on the initial posttest, regardless of which of the exhibit conditions the visitors originally acquired the exhibit information. An analysis of variance (Table 4) yielded no significant between-sessions

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Table 4.

Treatments		Pretest	E(NP)	E(I)	E	E(B)
	Means	3.72	4.37	5.92	6.80	7.29
Pretest	3.72	-	.65	2.20**	3.08**	3.57**
E(NP)	4.37		-	1.55*	2.43**	2.92**
E(I)	5.92			-	.88	1.37
E	6.80				-	.49
E(B)	7.29					-

* = $p < .05$

** = $p < .01$

Table 3. Newman-Keuls Analysis of Differences Between Means of the Pretest, E(NP), E(I), E, and E(B) Conditions at the Skull Exhibit.

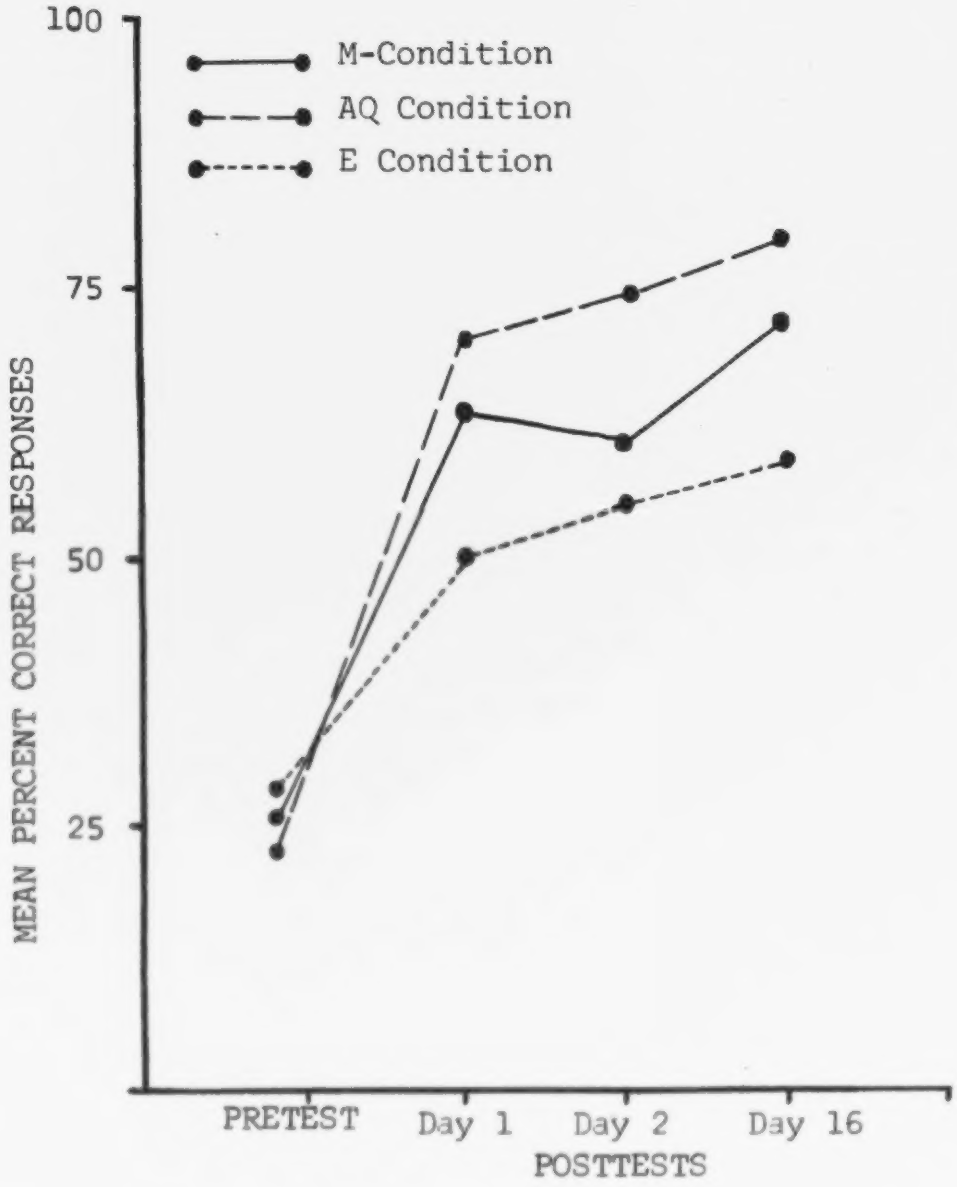


Figure 12. Pretest and Successive Posttest Performance in Twrms of Mean Percent Correct on Days 1, 2, and 16 of Retention Study

variance or treatments x sessions interaction. Differences between the groups were essentially the same as obtained in Study 1 (frequency distributions of the pretest and initial posttest scores for this replication were very similar in form as was obtained in Study 1). Therefore, as would be expected, there was a significant between-treatments variance beyond the .01 level (F = 10.164, d.f., = 2/40).

Study 5: Replication of Four Exhibit Learning Conditions in Hall of Religion.

In order to determine the replicability of the basic procedures and conditions used in the Age of Man Skull exhibit in producing visitor learning in a totally different museum location and different subject-matter, the exhibit learning conditions, M, AQ(w), E, and NP, were applied to a section of the Hall of Religion on the topic of animism and shamanism.

This, of course, required developing an entirely new set of criterion questions for use in pre and posttesting and a new set of programmed questions and accompanying audio for use with the exhibit.

A different pre-posttest machine, the MTA-400 shown in Figure 5, served as the testing device. Criterion questions were developed in a similar manner as was described for the development of the Skull questions. However, on the MTA test machine, the questions were not presented on slides, but on a continuous loop paper roll, and involved 4 rather than 5 choices, Visitor responses were recorded on an Esterline-Angus Event Recorder within the machine, the results of which were later analyzed by hand. From an original pool of 45 questions, using 40% rejection criterion,⑩ along with individual interviews with visitors, the total questions were finally reduced to 10 criterion questions (listed in Appendix D) plus two preliminary questions on age and schooling. The questions covered material found in two glass cases on the functions and methods of the shaman and animism among the Iroquis Indians.

The punchboard questions and audio script were developed in the same manner as the Skull Program. The objective was a single page sheet of questions and accompanying audio requiring from 10 to 12 minutes to complete and yielding better than 90% correct for at least 90% of the test Ss consistently over several weeks of testing. Because of the experience already gained from the Skull Program, this process took much less time. A final set of punchboard questions and accompanying audio (Appendix E) were completed after about 6 weeks of testing with about 250 visitors.

The study to be described here involved a total of 226 visitors of about the same age range (10 to 39 years in this case) with a median age of 15.0 years and 4 to 14 years of education.

The sequence of events was essentially the same as already described for the Skull exhibit procedure. Visitors inquired about the test machine (or other visible apparatus), were invited to take ("play") the pretest machine, then were sent to the exhibit cases with whatever exhibit learning system they had been assigned. The exhibit condition was followed by a posttest on the MTA test cachine. No feedback was available during pre or posttests.

Four groups of visitors were exposed to the religion exhibit under one of four exhibit conditions: M, AQ(w), E and E(NP, which were identical to the conditions previously described for these conditions. The n's for each group were 48 48, 80 and 50 respectively.

Results.

Pretest Results. The frequency distribution of pretest scores for the 176 Ss who took the pretest is shown in Figure 13 along

Figure 13.

with the theoretical chance distribution (dotted line).[12] As noted earlier, there was greater pre-exhibit knowledge of the animism-shamanism topic among visitors than there was of the Skulls (Mean = 39.3) or about 14% above the mean of 25% which would be expected by chance. Nevertheless, the pretest curve is very similar in shape to the chance distribution and to that obtained on the Age of Man pretest.

Posttest Results. The frequency distributions for each of the four posttest conditions are shown in Figures 14, 15 16 and 17,

Figures 14, 15, 16 and 17.

compared in each case with the combined pretest distribution. The results for the four conditions appear essentially the same for each of the conditions as obtained at the Age of Man exhibit, with nearly 48% achieving a 92-100% posttest score under the M condition (n = 48) and nearly 38% achieving these levels under the AQ(w) condition (n = 48). Some visitors (16% of a total of 50) still achieved the 92-100% level under the E condition.

An analysis of variance[12] yielded a significant between-treatment variance beyond the .001 level (F = 19.26, d.f. = 3/222). A Newman-Keuls analysis of the differences between means (Table 5)

Table 5.

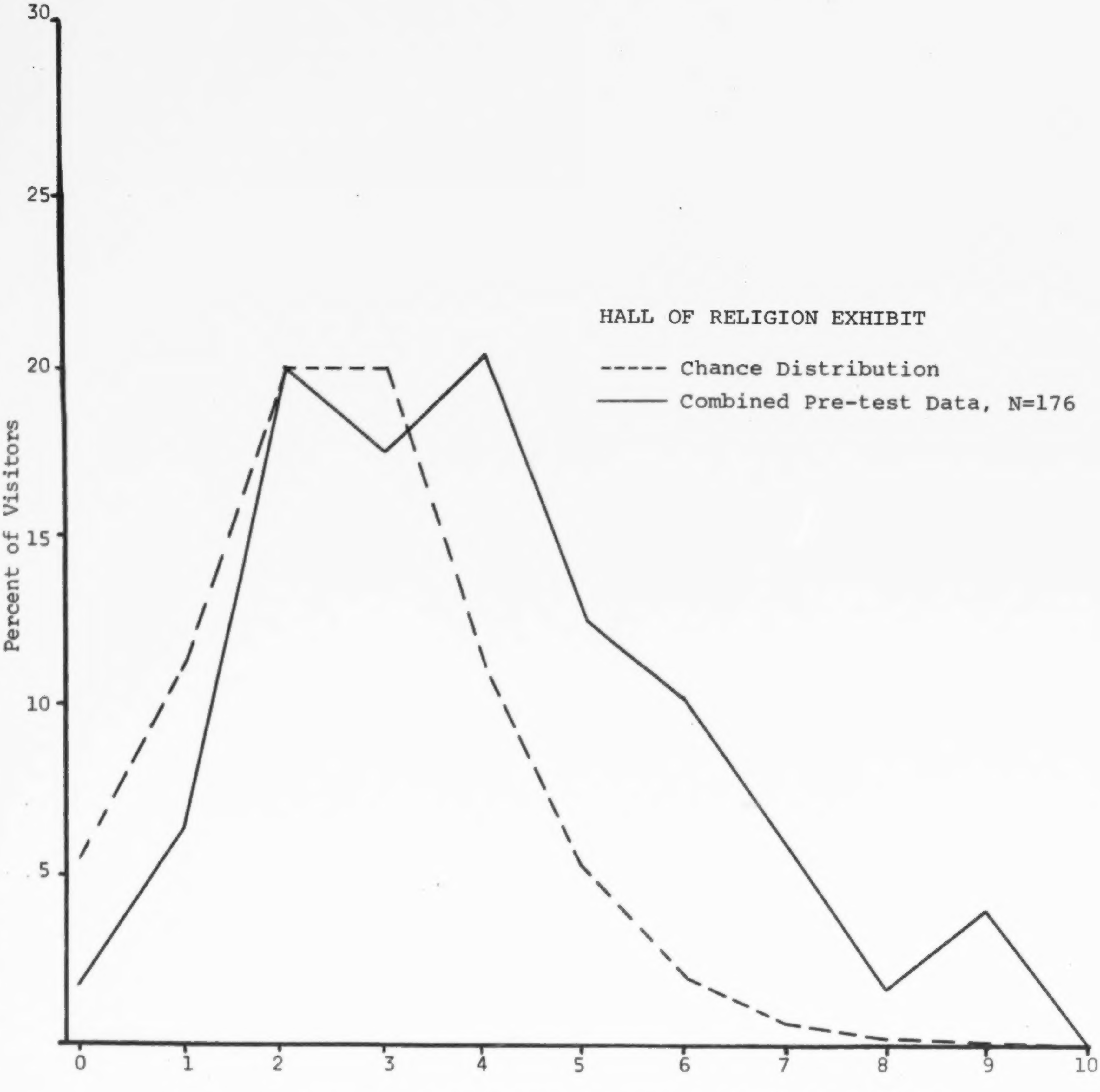


Figure 13. Frequency Distribution of Pretest Scores for Religion Exhibit (n = 176) Compared with Expected Chance Score

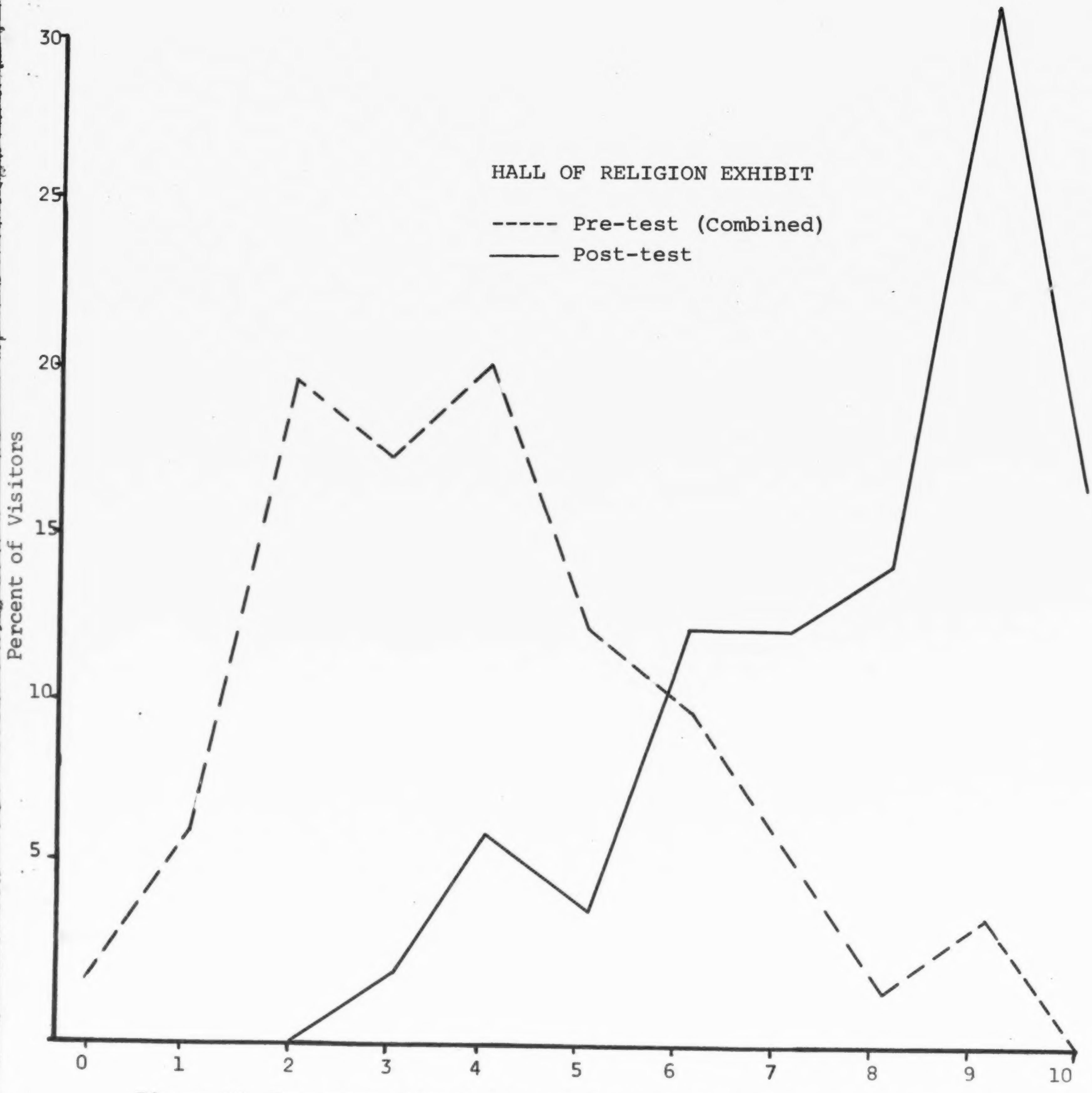


Figure 14. Frequency Distribution of Posttest Scores for M-Condition at Religion Exhibit (n = 48) Compared with Pretest Scores (n=176)

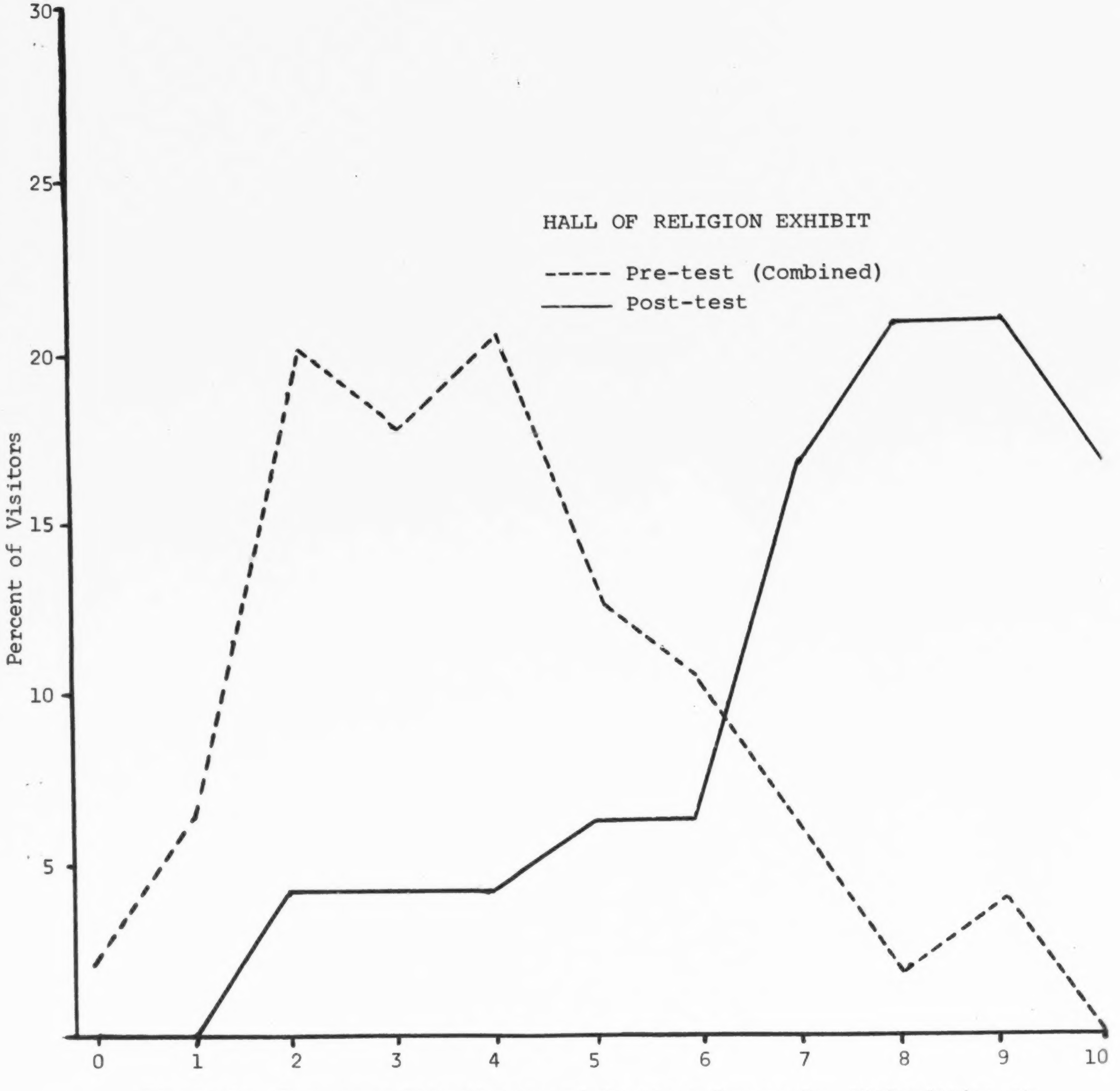


Figure 15. Frequency Distribution of Posttest Scores for AQ-Condition at Religion Exhibit(n=48) Compared with Pretest Scores (n=176)

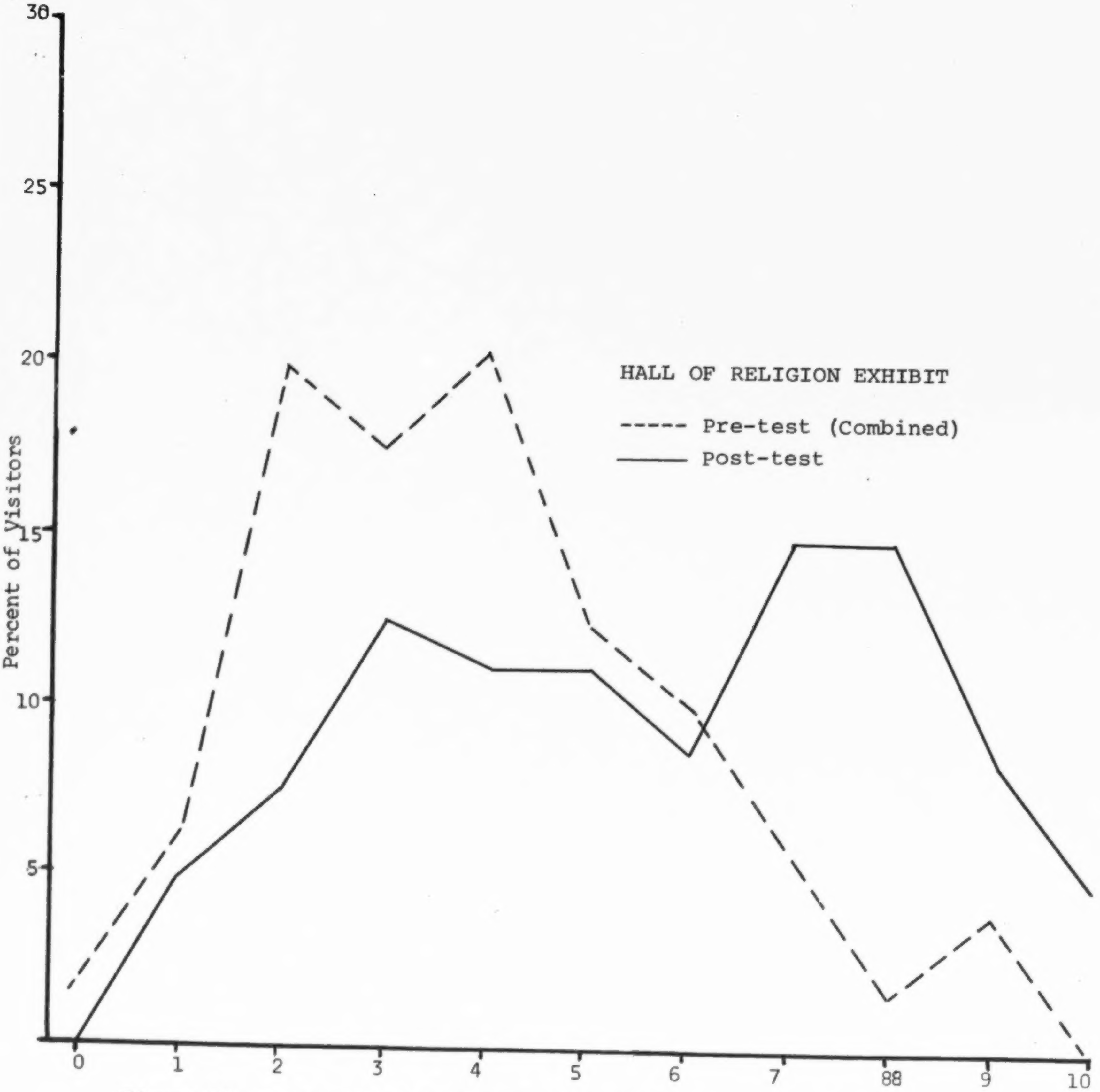


Figure 16. Frequency Distribution of Posttest Scores for E-Condition at Religion Exhibit (n=80) Compared with Pretest Scores (n=176)

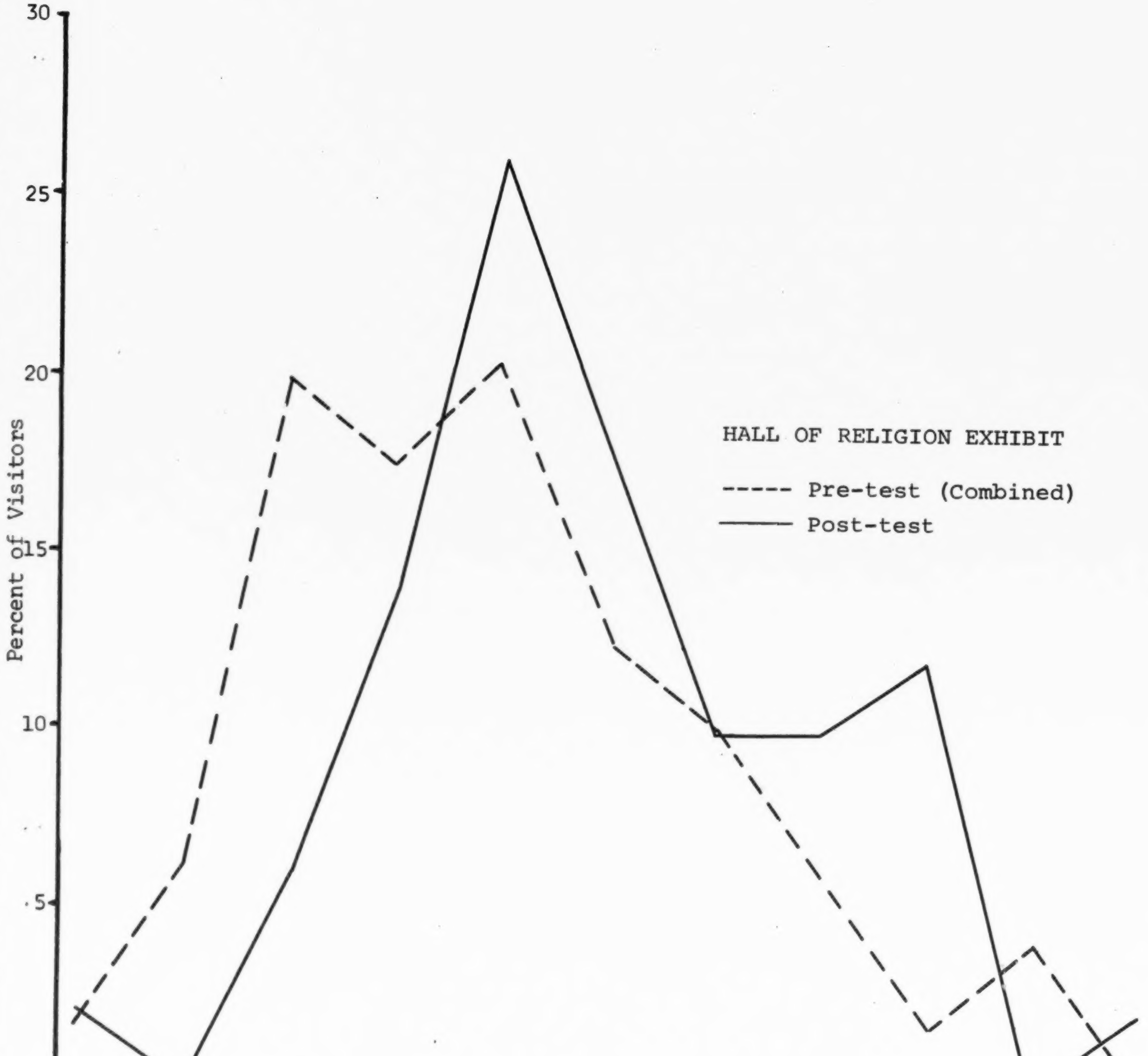


Figure 17. Frequency Distribution of Posttest Scores for E(NP)-Condition at Religion Exhibit (n=50) Compared with Pretest Scores(n=176)

Treatments		E(NP)	E	AQ	M
	Means	4.94	5.86	7.79	7.83
E(NP)	4.94	-	.92*	2.85**	2.89**
E	5.86		-	1.93**	1.97**
AQ	7.79			-	.04
M	7.83				-

* = $p < .05$

** = $p < .01$

Table 5. Newman-Keuls Analysis of Differences Between Means of the E(NP), E, AQ, and M Conditions at the Display on Animism and Shamanism in the Hall of Religion.

indicated no significant differences between the M and AQ(w) conditions, confirming the result with the Skull Program studies; and again, there were significant differences between the E condition and the M and AQ(w) conditions ($p < .01$). While less than the M and AQ conditions, the E condition was significantly better than the E(NP) condition where no pretest occurred.

Study 6: Effectiveness of Pre-Exhibit Treatments on Exhibit-Only Learning.

As in the case of the Age of Man Skull exhibit, we wished to determine the effects, if any, of studying the exhibit alone without a pretest in producing performance above pretest performance and if the pretest condition by machine (Condition E) was any different from the pretest experience via the booklet (Condition E(B)). Therefore, an additional group of Ss (n = 50) were run taking the pretest by booklet rather than by machine (E(B)).

The posttest performance of this E(B) group was then compared with the E and E(NP) groups of Study 5 and the original pretest scores of these three groups. An analysis of variance which included the pretest scores as a fourth condition yielded a significant between-treatments variance beyond the .001 level (F = 21.45, d.f., 3/256). This was followed by a Newman-Keuls analysis (Table 6) of the differences among the means of the four conditions.

Table 6.

As was also found in Study 4, there were no significant differences between the booklet and machine forms of pretest administration. There were significant differences between the no pretest (E(NP) condition and the two pretest conditions, E and E(B), as may be seen in Table 6.

One result which was not obtained in the analysis of exhibit-only conditions at the Age of Man exhibit was the significantly better performance of the E(NP) group over baseline pretest performance. In other words, the performance of visitors was apparently improved by studying the animism-shaminism exhibit without benefit of pretest, although the results were not as good as when a pretest had first been experienced (Group E).

This last result supports the idea that museum visitors do sometimes learn things simply from looking at an exhibit, reading the labels, etc. The fact that such a result was obtained on the animism topic and not at the Age of Man exhibit may simply mean that the bases for skull discriminations were not as clear in the skull exhibit as were the functions and methods of animism and shamanism. In the latter case, reading one or two of the rather short labels in the religion exhibit could have provided some of

Treatments		Pretest	E(NP)	E	E(B)
	Means	3.80	4.94	5.86	6.56
Pretest	3.80	-	1.14	2.06	2.85
E(NP)	4.94		-	.92	1.62
E	5.86			-	.70
E(B)	6.56				-

* = $p < .05$

** = $p < .01$

Table 6. Newman-Keuls Analysis of the Differences Between Means of the Pretest, E(NP), E, and E(B) Conditions at the Display on Animism and Shamanism in the Hall of Religion.

the necessary information measured in the posttest. The labels in the Skull exhibit were more involved, longer, and more subtle. Also, the vocabulary required in the religion exhibit was simpler than that required for the Skull exhibit. In any case, whether it was the better design of the exhibit cases or the greater pre-exhibit knowledge of the visitors, some learning apparently did occur for the E(NP) group.

IV. RECYCLING SELF-TESTING SYSTEM

The concept of the "recycling test system" evolved from our observations that in various replications of the E condition, from 15 to 20% of the visitors who had taken a pretest were able to achieve very high posttest scores (92-100%) without the use of any programmed systems at the exhibit.

This suggested the possibility that the pre-exhibit self-testing situation might be developed to facilitate later learning from the exhibit without the need for programming the exhibit itself. The use of programmed materials under the M and AQ conditions described earlier, while very effective, are expensive to develop and would pose many difficulties for most museums to implement.

A difficulty with the use of the pretesting experience alone, however, is the fact that relatively poor results were obtained under this condition compared with the M and AQ groups. The use of a printed set of instructions (E(I)-condition) did not do any better and the use of booklet pretests (E(B)) made no difference. The results might be improved by the use of feedback during pretesting, although this was not investigated. The variable of feedback during pretesting would require the use of a different set of matched criterion questions during posttesting, but it is possible that feedback would improve visitor posttest performance under the E condition. The smaller number of visitors who benefited from the pretest experience may have also reflected individual differences in the ability to "process" exhibit information. Supportive audio and other programmed materials at the exhibit may help those persons who normally are poor information processors by selecting out and ordering the relevant information for them.

The "recycling" system to be discussed here was developed to help those visitors who have more difficulty in processing (on their own) exhibit information in relation to instructional objectives. The aim is to provide a situation in which visitors will recirculate through the exhibit between successive criterion tests (with feedback) until they achieve the desired mastery of the instructional objectives for which the exhibit (and tests) were designed.

As developed in this project, the recycling system must have the following features:

(a) It must attract the passing visitor to play it;

(b) It must provide the visitor with very specific knowledge of what he must learn to do as the result of studying an exhibit in the form of a short set of criterion questions;

(c) It must encourage the visitor to go to the nearby exhibit after completing these questions and attempt to gain the information necessary to master a set of similar questions;

(d) The visitor must be motivated to return to the test machine to retest himself on a similar set of questions and obtain feedback or a score reflecting the success of his efforts;

(e) If he does not achieve mastery (a high score) on this retest, the visitor must be motivated to return to the exhibit and back to the test machine and to continue to recycle until he achieves mastery of the specific behaviors reflected by the test questions.

A prototype self-testing system was developed, based on the above objectives. The prototype system uses a commercially available public-access self-testing machine modified to meet the above requirements.(13) The prototype machine incorporating these modifications is shown in Figure 18. The title of the machine,

Figure 18.

"Try A Game" was based on preliminary observations of the ability of this name to attract visitors to the device.

The operation of the machine as well as the basic procedure followed by the visitor in our initial testing of this system can be illustrated schematically in the Flow Diagram in Figure 19 and may be described as follows:

1. The visitor approaches the machine and discovers that for 10¢ he may test his knowledge on the topic listed on the machine and available in a nearby exhibit whose picture is on the face of the machine. He also discovers that he can win an "expert Medal" from the machine if he achieves 450 (out of a total possible 500) points on the test. A sign suggests that he should first study the exhibit before taking the test. (Our system does not require he does this.)

2. When the visitor deposits his 10¢, the device lights up and the first of 5 multiple-choice questions appear on the 9 x 9-in. screen. These 5 questions are from a total pool of 100 such questions covering the same subject-matter. (The machine itself can, if necessary, hold up to 6,000 questions.)(14) The player has up to 30-secs. to answer each question.

3. A correct choice results in: (a) onset of a green light by the answer button, (b) the addition of 100 points on the counter (upper right-hand corner, Figure 18), and (c) onset of a "Go Button" light which will advance to next question when pressed. Answering incorrectly results in (a) onset of a red light by button, (b) a buzzer, (c) a drop in possible points from 100 to 50 which can be earned for a correct answer, (d) no addition to score on the counter, and (e) another chance to select an answer. If visitor is correct on his second choice, he receives 50 points on the counter and the other events described. If wrong again, he must continue to choose until he finds the correct answer, but he receives no points.

4. At the end of the 5-question game, the machine dispenses one free-play token in a small cup (lower right-hand front, Figure 18), regardless of his total score. This token has the printed message "One Free Play, Study Exhibit and Try Again."

5. At this point, it is intended that the visitor will be motivated to go to the nearby exhibit and study it, rather than deposit the token for another game. On the basis of the results obtained under Condition-E in our earlier studies, we expect that this testing experience will facilitate processing relevant information from the exhibit;

6. After visiting the exhibit, the visitor is expected to return to the test machine (motivated by his possession of a free play token) where he will receive a similar 5-question test over the same topic;

7. After answering this new set of 5-questions, one of three things can happen depending upon his total score:

   (1) if the visitor obtains a poor score of less than 250 points reflecting poor cooperation, the game ends for him (unless he puts in another 10¢).[15]

   (2) if the visitor obtains 250 points or more (reflecting at least some learning), he receives another free-play token as before which instructs him to "study the exhibit and try again."

(3) if he receives a score of 450 points (mastery level), he receives a gold colored token (called a medal) with the words "MUSEUM EXPERT" printed on it. The visitor may keep the token, or it may be used for a free replay on other self-testing machines.

Our previous studies led us to believe that many persons will get enough from a single pretest to facilitate some learning from the exhibit and should make it likely that they can achieve at least 250 points on their second try at the test machine and win another free-play token, as well as successive tokens for further replays. It is assumed that each successive run through the 5-question test sequence will provide the player with an additional sample of the specific behaviors to be achieved from the exhibit. Also, the tests will provide additional practice in what has already been learned.

Thus, while only a relatively small percentage of visitors may achieve mastery after their first test and visit to the exhibit a much larger percentage may be able to achieve mastery if successive tests and exhibit visits are provided.

Such a system, of course, assumes the cooperation of the visitor in trying to improve his test score and obtain ultimate mastery, using the exhibit in order to achieve this improvement. The motivational features of the test machine shown in Figure 18 (counter, points, lights, free-play tokens and gold "Expert Medal") are all intended to encourage such cooperation and motivate the average visitor to recycle through the exhibit as many times as necessary to achieve mastery.

The advantage, of course, is that if this is indeed what happens, the expensive problem of programming responsive guidance systems at the exhibit to help the visitor select and order relevant exhibit information is avoided. Instead, the visitor is left to "program" the exhibit information with respect to a specific instructional goal on his own time and in accordance with his own particular needs. The self-testing situation provides repeated definitions of the instructional objectives involved, feedback to the visitor concerning the success of his efforts, and a game-like motivational situation encouraging the required time and effort.

If the visitor does continue to use the free-play tokens and tries to achieve a "Museum Expert" medal, he should eventually learn if free replays and the eventual "expert" prize are contingent on learning the predefined exhibit material.

In order to test such a system, four sets of 40 multiple-choice test questions were prepared and filmed for use in the machine shown in Figure 18. Each set covered topics found in the nearby exhibit area, viz., Evolution, Heredity, Seed Dispersal Mechanism, and Animal Age and Movement. The pool of 50 questions was organized into successive 5-question games. The player could select which of the four topics he wished to be tested on by pressing the appropriate category button on the machine.

Sample questions from each of the four topic areas are given in Appendix F.

Preliminary observations of the system involved placing the machine about 20 feet from the reference exhibit area (located in one of the sub-areas in the Hall of Life) and over 2-hour periods unobtrusively observing visitor reactions, replays, cooperation, in recycling, etc.

From these initial rather informal observations, it was apparent that the machine did attract both younger and older persons to stop and examine it (or watch others play it). About 25% to 30% of the passing visitors in our 2 hour samples stopped; roughly about 25% played it. More younger persons than adults played it, but the average age level appeared higher than the 14 to 15 year level of the programmed systems described earlier. This could have been due to the 10¢ cost for the initial play. Family and peer groups were observed often to play the machine as a group. Under the conditions of these preliminary observations, it was difficult to obtain exact data on individual recycling activity or resulting performance on questions. However, persons were observed going to the exhibit area and returning with free-play tokens to replay. Others continued to replay without going to the exhibit. Some persons did not seem to understand what was required. One of the most serious difficulties was the use of the four category buttons which allowed visitors to select different topics on which to be tested. Changing categories from one play to another was common. Some persons changed categories during a game.

A more careful effort to obtain more adequate information concerning the ability of the question machine to produce repeated visits to the exhibit and improve test performance was recently completed. The category buttons were removed and the machine was preset to present questions over a single topic: Heredity. A picture of the reference display case where the answers could be found was prominently displayed on the machine with the instructions: "Study this display at the exhibit and win an expert medal!"

All data was collected as unobtrusively as possible by a single observer who stood near the machine area so that he could follow the movements of the players who approached and played the machine, record their scores, etc. Not all persons who played the machine in succession were selected for observation. Since it was difficult to follow the actions of family or peer groups or to evaluate the results of recycling, etc., these were excluded. Also excluded were younger children below about 12 years of age. Some players who had been initially observed were lost track of in subsequent plays and, therefore, their initial data has been omitted from the data to be presented. Persons who replayed with 10¢ were also omitted.

Observations took place over approximately two-hour periods under relatively crowded conditions on Saturdays and Sundays. The machine remained on the floor when no observations were being made, but was unplugged.

Observations took place over approximately two-hour periods under relatively crowded conditions on Saturdays and Sundays. The machine remained on the floor when no observations were being made, but was unplugged.

A total of 32 persons were observed and followed through to the point at which they either left the situation, or achieved mastery. The results of these observations are summarized in Table 7. While the number of persons observed is small, the results are encouraging. Of the 32 persons involved, 15 or about 47% achieved mastery level over 4 replays. One person achieved on his initial (10¢) test, presumably before seeing the exhibit. Six persons ultimately achieved mastery by taking successive retests without visiting the exhibit. There was an increasing tendency during later replays to replay without returning to the exhibit. Of the 31 persons who did not achieve mastery on their initial test, about 61% did initially go to the exhibit prior to taking a retest. Everyone replayed the test machine with their first token. Only 6 persons (about 8½%) walked away with a free-play token without using it in the machine.

Table 7.

Because of the small sample, these results are very tentative, but nevertheless encouraging. This initial test is difficult to evaluate and has pointed up a number of difficulties in achieving the objective of facilitating learning from the exhibit.

The particular questions used were not as dependent as they should have been on studying the exhibit. By taking the initial 5-question test, it was possible to learn some of the information required in the subsequent 5-question test which, in turn, taught more, and so on. The questions should have been asked in such a way that they would not make much sense without having been at the exhibit. Even more important, however, was the rather poor design of the questions themselves. They were not properly screened in terms of pre-exhibit performance and consequently were too easy and the tested information was often trivial.

Type of Play	Total Avail. for Play	Did Not Return to Replay	Replayed Without Returning to Exhibit	Returned to Exhibit	Scores Achieved			
					Below 250	250-400	450-500	Mean Score
10¢ Play	32	-	-	-	12	19	1	225
Token #1	31	0	11	19	8	16	7	315
Token #2	16	3	5	8	1	8	4	365
Token #3	8	2	5	1	0	4	2	383
Token #4	4	1	3	0	1	0	2	

Table 7. Number of plays, replays and scores obtained by 32 visitors at the self-quiz recycling machine on the topic of heredity.

Another problem was that the test machine, with its feedback and advance only-on-correct features, served as a rather effective teaching machine that could teach *independently* of the exhibit. Visitors gradually discovered this and, as may be seen in Table 7, an increasing proportion remained away from the exhibit and simply played the machine. It is difficult to say how much of the improvement that did take place in scores was due to the actual exhibit and how much to the teaching properties of the machine.

The feedback and scoring system motivated persons to play the machine and, apparently, to learn from it, but they also made it possible to learn from it *without* the exhibit! On the basis of the results of this initial test, it appears that the quiz machine, if it is to be used as a recycling system, will probably have to have some of its teaching features removed. The task is to do this without at the same time losing the motivational characteristics of the machine.

One of the effective teaching features of the prototype machine is the feature of advancing only on correct answers, allowing the player to make successive choices until he discovers the correct answer. In the revised models to be used in future tests, the player will have only one chance to answer. If he is correct, he will receive 100 points and a new question; if he is wrong, he will still receive a new question (along with a red light). He could, of course, still learn through continued play, but if he wishes to receive replay tokens and an expert medal, it will be faster and easier to use the exhibit. Other features of the new models include (a) removal of the buzzer for wrong answers (this appears to be more threatening to adult players), (b) a built-in print-out response recorder which records each play along with correct and incorrect responses, (c) a better system for instructing the visitor about the system using the question screen to present instructions,[16] and (d) the possibility of removing feedback to specific questions altogether, but continuing to pay off tokens based on performance.[17]

V. CONCLUSIONS AND RECOMMENDATIONS

Progress in recent years in the use of programmed learning, responsive teaching machines and computers for instruction in more formal educational situations has led to the general acceptance of such technologies as a basis, at least in principle, for improving the efficiency of education. The present project has raised the question as to whether such systems might also be utilized for educational and communication purposes in public environments such as museums.

The results of the present project have shown that substantive learning can occur in the museum (one type of public environment) through the use of programmed responsive systems at exhibits[19] such as audio cassettes and question-answer devices.

Through the use of game-like pretest-posttest machines, the results have shown that a museum exhibit, or exhibit system can be subjected to the same kind of evaluation in terms of terminal visitor performance as used in evaluating any would-be instructional or communication procedure. Data from the many museum visitors who participated in the project under various exhibit conditions have indicated that the effectiveness of any exhibit system probably depends upon the same considerations that determine the effectiveness of any instructional procedure: careful definition of the behavioral objectives of the exhibit both to the designer and the would-be learner, two-way interaction between the learner (visitor) and the exhibit, frequent feedback to define progress toward some instructional goal, and so on.

In Chapter I, we described the museum as an attractive, open learning environment, but with some inherent problems which lower the likelihood that effective communication and learning will take place within. Among these were the heterogeneity of the museum audience, the absence of any particular learning goal on which the visitor can base his exploration, and the essentially passive, one-way nature of most exhibits which are not, or cannot, be responsive in any way to their viewers.

The methods employed in this project have attempted to deal with these difficulties by (1) employing interactive or responsive systems which focus the visitor's attention through successive steps toward a specific behavioral objective and provide frequent feedback and motivation to continue,(18) and (2) by employing separate game-like self-testing devices to measure the outcome of the visitor's exhibit experience in terms of its objectives. In the recycling procedure described in Chapter IV, the self-testing device not only measures the learning that has occurred, but also (theoretically at least) helps the visitor to process the exhibit information on his own.

Those studies involving the use of the punchboard-audio system to focus and control the attention of the visitor through a fixed display indicated that the system was most effective in attracting the younger (below 18) person and holding his attention. The system produced significant learning in at least half of all of the participants and was able to bring approximately 40% of the participants to a 92 - 100% level of posttest achievement.

Of course, it would not be correct to conclude that it did this with a representative sample of *all* museum visitors. Only about 25% of the participants were adults and the data were based only on those persons who were attracted by the machines, signs, etc. Therefore, our population was perhaps a more "motivated" group, more ready to cooperate and more ready to learn. But, whatever their characteristics, they represented a large proportion of the younger persons who passed near the exhibit area.

The use of overt responding to questions (via the punchboard) with immediate audio and visual feedback to correct answers was initially believed to be necessary to obtain sustained attention and cooperation by a noncaptive, voluntary group through the 10 - 12 minutes at the exhibit. However, from comparisons of the so-called *M* and *AQ* conditions in both the Skull exhibit and the Religion exhibit, this proved not to be so. The use of the audio cassette alone (which asked the questions vocally) worked as well in producing a high level of posttest performance (see Figures 8 and 9) as having the questions answered on the punchboard.

The role of the questions themselves is less clear, but the results obtained in these studies appear to favor better performance where questions were used. Much needs to be done in establishing the facilitative properties of audio with and without attention controlling questions. The audio scripts used in the Skull study which provided the "questions" versus "narrative" conditions were not well suited to do this.

Most visitors exhibited little if any learning from the exhibit when they had no guidance devices and no pre-exhibit test or other knowledge of what was expected of them (the E(NP) situation). This result does not auger well for those museum educators who believe that the static museum display, if carefully designed and artistically arranged, will "communicate" the ideas contained therein to the interested visitor. There were no differences between the normal pretest performance and the posttest performance of those who had studied the Skull exhibit, without aids or prior pretest, before taking the posttest. On the other hand, some learning *did* occur under these conditions (Study 6) at the Religion exhibit, although the results were significantly poorer than under the other exhibit conditions. The Religion exhibit was more clearly related to the requirements of the posttest questions, the labels were shorter and to the point, etc.

Obviously the physical design of an exhibit, the simplicity of its instructional objectives, the clarity of its labels, etc. can influence whether some particular instructional objective will be communicated. But, at best, the use of the static display without aids, pretests, etc. greatly limits the subtlety of the instructional material which can be communicated and the number of persons who are likely to profit from it.

One of the most interesting results of the project was that the amount of learning that will occur while looking at an exhibit without audio or other supportive aids, is significantly facilitated by taking a pretest prior to visiting the exhibit. This was the case, even though no feedback or knowledge of results was given during the pretest. From 15 to 20% of the visitors who had been given a no-feedback pretest prior to studying the Religion or Skull exhibits on their own, achieved 92 - 100% posttest performance.

Although the overall effectiveness of the prestest was less than when the audio or punchboard devices were used (Figures 10 and 16), the pretest experience apparently helped some visitors to effectively process relevant information from the exhibit on their own without benefit of programmed materials, etc. It seems likely that the pretest served to define for these persons the specific objectives of their exhibit visit. For example, having seen questions about the ordering of Skulls according to age, they subsequently attended to the skull orders in the exhibit, and so on.

If this effect was a matter of providing the visitor with an idea of what he was supposed to learn, what to organize, etc., the effect might also be produced by means other than a pretest. Our substitution of a simple statement of objectives in place of the pretest (Condition E(I)) also produced significant improvement over normal pre-exhibit performance.

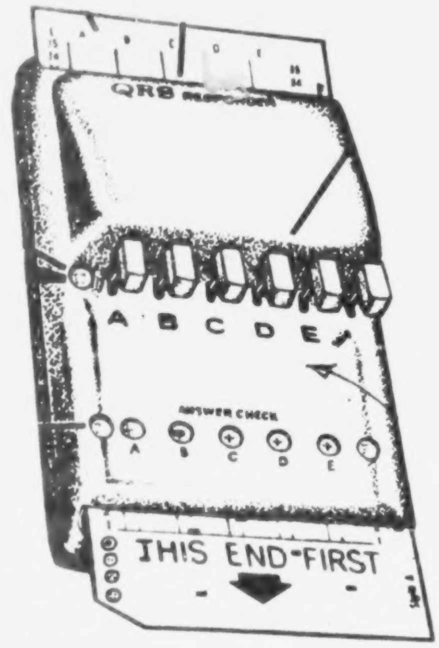
Other methods of providing exhibit previews, pretests, or learning goals need to be more carefully investigated.[29] It is possible that improved forms of pretesting and exhibit previewing could greatly improve the results obtained here for the E-Condition. In any case, these results have raised the interesting possibility of facilitating what visitors get out of fixed, nonprogrammed exhibits by using preview quizes and tests to define the learning goals of such exhibits. The "recycling" procedures, discussed in Chapter IV, are one approach to mobilizing the exhibit test for this purpose.

The time between exposure to the exhibit system and the posttest averaged about two minutes. The retention study attempted to determine if the learning that took place under the M, AQ, and E conditions at the Skull exhibit would be retained after 2 and 16 days. The results of the retention study supported our expectation that the results would be retained. Each group maintained its previous level of posttest performance over the 16 day period.

In general, the results of the project support the position that in order to reach the majority of museum visitors and to extend the complexity and depth of the material to be communicated by museum exhibits, some sort of control over visitor observing behaviors and information processing activities in relation to specific learning goals, is necessary. The use of individualized programmed audio-cassette tapes, with attention guiding questions and feedback coordinated with learning goals, is one way of achieving such control and producing a high level of terminal performance in the majority of visitors who participate. The use of simple types of responsive question-answer devices, such as the punchboard of our studies, is another way of doing this. However, problems were encountered in obtaining participation of many of the adult visitors to such systems. Adults will more readily approach and respond to an unsupervised (automated) device, especially if it appears that their performance will not be on public view.

While we accompanied the use of our punchboard device with coordinated audio, we did not investigate the possible effects of using the punchboard alone, without audio. While the use of audio provides a simple method of telling the visitor where to look, in what order to look at specific things, and the relations among these things, audio is not necessarily the only, or the simplest way of accomplishing these things in some exhibit situations. Programmed questions presented by responsive question-answer devices without audio and coordinated with exhibit information could, in many instances, control observing behaviors, establish key discriminations, etc.[20]

One simple response system for use by individual visitors (see insert) can be programmed to operate by inserting a prepunched IBM card.[21] It is very light, small (3½ X 6-in.), and provides the user with immediate feedback after correct answers (a green light). Each response punches a hole in the IBM answer card. The visitor can have the option of turning in his card to be scored, or he can score himself if he wishes. This unit is currently being tested with visitors at the Skull exhibit, and will be used with a programmed contemporary art exhibit at the Milwaukee Art Center.



The present project has limited itself to the use of programmed materials or adjunctive testing situations to be used by visitors in viewing a fixed, unprogrammed, unresponsive physical exhibit. Another approach to securing the guided attention, active responding and feedback discussed in this Report, of course, would be to build them into the physical exhibits themselves. With appropriate electronic controls, the exhibit itself could secure answers to questions from visitors, provide immediate feedback, focus attention to various parts through built-in audio, lighting, etc. In such a case, the physical exhibit itself, if it engages and guides its viewers in relevant observing activities, would become a kind of massive "teaching machine." The physical arrangements of such programmed exhibits would allow viewers to *interact* with them and, in the process of interacting, achieve specific instructional goals.[19] The exhibit and the viewer could be linked together by means of small computer terminals located at each exhibit and through which viewers could obtain instructions, answer questions, *ask* questions, test themselves, etc.

The possibility of providing programmed, interactive exhibits raises the topic of computers and the possibilities of going beyond the concept of programming a single display to communicate specific information and simple concepts. The vast capabilities of the computer raises the possibility not only for developing individualized learning systems around individual exhibits, but for harnessing the entire museum as an open, responsive, learning environment. With its vast memory potential, its capabilities for high speed information retrieval and data processing, and for problem solving and simulation, the computer has immense implications for realizing the full potential of the museum as an open learning environment.

To date, the computer's role in museums has been almost nonexistant, and where it has been even considered, discussion has centered on its role for record keeping and administrative functions. But, the real potential of the computer's capabilities is as an instructional device which could mobilize all of the resources of the museum to meet the individual learning needs of the visitor; it could converse with him, challenge him, test and evaluate him, relate his interests to exhibits, and help him explore their implications.

The computer could not only provide direct instruction on particular topics, but could develop the visitor's abilities for inquiry and investigation, using the museum's exhibits as the framework for such activities. It could challenge the visitor to explore the museum environment to achieve specific learning goals and manage his movements and exploratory activities so as to maximize the chances of his achieving his goals. The computer could provide learning experiences in its own right that could develop new perspectives, and new skills and interests. The computer could simulate a political or social system, an historical event, etc. requiring the visitor to ask a series of questions, organize facts, apply principles, predict consequences, discover defects, evaluate decisions, and so forth. It even could referee problem solving activity in simulated social, political, economic and other situations. Thus, the computer goes beyond the "teaching machine" or programmed exhibit system which attempt to automate tutorial instruction because, unlike the ordinary programmed learning situation, the computer is not limited to a set of finite "correct" responses, but can provide for "open ended" responses, carry out dialogues, a and so forth.

All of these methods, of course, are likely to be expensive, and beyond the budgets or staffs of many museums. Programming interactive exhibits, with or without the computer, would probably be the most costly to develop and maintain. If the procedures utilized in this project were to be followed, each system would have to be designed from a set of carefully defined behavioral objectives and validated on the basis of the exhibit system. This would mean testing visitors during development, revisions in design, etc. until the objectives were achieved (x-percent of participants achieving x-percent posttest performance). All of this would be time consuming and expensive and onto this would be added the costs of constructing and maintaining the electronic memory, information retrieval and response components of the exhibit itself.

Somewhat less costly, would be to use existing displays, as was done in the present project, and developing programmed audio or programmed questions for use on portable feedback devices to relate the visitor to these existing displays. In this case, the costs of the built-in electronic controls of the interactive physical exhibit would be saved. However, the development, initial revisions and testing of the programmed audio or other adjunctive materials would still be necessary.

While developing such programmed materials would probably be beyond the present technical skills of most museum staffs, a start in developing some programmed materials for exhibits might be made through cooperation with university educational and psychological researchers and perhaps with some industries in the instructional systems area. Also, museums might make good use of some of the best off-the-shelf instructional packages now becoming available from publishers and AV manufacturers for the school markets, some of which would be closely related to existing museum exhibits and could be readily coordinated with them in the ways described in this Report. (See Hendershot; also Intelek's Programmed Instruction Guide, 1968.)

Of course, if the potential effectiveness of interactive exhibit systems or programmed audio or response systems is as great as the results of the present project have suggested--that is, the guaranteed achievement of a large proportion of participating visitors--then, the expense of providing such systems within museums might be well worth their cost. The M and AQ procedures described earlier achieved a high level (92 - 100%) of achievement in about 40% of the participants. It seems very likely to us that, with added care and experience, the materials and procedures of the M and AQ conditions could be improved sufficiently to bring this level of achievement to 60 or 70% of the persons exposed to them.

As pointed out earlier, the programming of exhibits or the use of programmed audio and other devices at exhibits are not the only possibilities for helping the visitor learn from exhibits or profit from his museum explorations. There may be less costly approaches to facilitating learning in the museum environment. On the basis of our own observations in this project, two of the most promising of these approaches are the use of (1) game-like, public-access teaching machines to provide indepth and supplementary treatments of surrounding exhibit topics, and (2) the recycling system (Chapter IV) to help visitors to process nearby exhibit information at their own pace and on their own time.

Public-access teaching machines could be provided in and around exhibits and present short programmed presentations (probably via film as in the device pictured in Figure 18) supplementing or complimenting the subject-matter in the immediate area. With an advance-on-correct feature and other corrective feedback features and perhaps a self-scoring system, such devices should motivate many passing museum visitors to use them, and learn from them. Our efforts to use the machine shown in Figure 19 with all of its corrective and scoring features to motivate persons to use the nearby exhibit to learn, showed that many persons not only played the machine repeatedly but some ultimately achieved mastery by playing the machine instead of visiting the exhibit. Such devices are relatively low in cost. Their costs could be reduced further by making them coin operated, except for the fact that this would eliminate its use by the very poor. Such a machine, however, could return free-play tokens to those who achieved low error scores and thus lower the cost for those visitors who are cooperating. The programmed materials which could be used in such machines could be adapted from short off-the-shelf audio-visual and film-strip programs selected for their topical relevance to the exhibit. As mentioned earlier, there are many such materials now becoming available from publishers on hundereds of topics from art history to atomic physics which could be used in the appropriate exhibit areas to provide background, greater breadth of coverage, and indepth understanding of the topics to which the exhibit area is devoted. (For a list, see Hendershot or Intelek's Programmed Instruction Guide, 1968.) The costs of off-the-shelf materials would be small and their adaptation for public access would be far less costly than the cost of "inhouse" development of materials.

In contrast to the teaching machine, which is designed to provide all of the necessary instruction from the machine itself, the recycling system uses the exhibit as the primary source of instruction and motivates the visitor to study it by a quiz machine which pays off tokens for mastery. Such a system, if it could be made to work, would save the cost of programming the exhibits themselves and require only the development of a pool of criterion questions, probably by museum staff. The feasibility of such an approach is based on the project's studies which showed the facilitative role of the pretest on learning from the unprogrammed exhibit. The recycling system attempts to help visitors achieve mastery of unprogrammed exhibit topics by providing a quiz game which motivates him to make repeated visits to the exhibit to improve his quiz score. The system assumes that his ability to ultimately achieve mastery will depend upon:

(a) his understanding of the learning objectives gained from the machine's criterion test questions;

(b) his own particular skills in processing information;

(c) the care with which the exhibit information relating to the mastery criterion have been clearly displayed; and

(d) his "motivation" or interest in the goal of achieving a high score on the test questions which define the learning goal.

Results from our initial observations of a recycling system, although tentative, were encouraging. They indicated that:

(a) both younger and older persons were attracted to the quiz machine (Figure 18) and "played" it;

(b) at least half of the persons who played it and obtained a free-play token did visit the exhibit and return to replay the quiz machine with their token; and

(c) some visitors did continue to "recycle" from test to exhibit and back until they achieved mastery;

(d) the machine used in this test proved to be too effective as a teaching device in its own right which enabled visitors to improve their score and even achieve mastery by playing the machine alone without visiting the exhibit.

This last result supports our belief, expressed earlier, that such public-access teaching machines could motivate persons to use them and learn from them. But, this result also indicates that, if the exhibit, rather than the machine, is to serve as the learning source, the recycling quiz machine cannot do its own teaching. To achieve this, it appears to be necessary to remove many, if not all, of its specific feedback features, keeping only those features essential to motivate return to the machine (such as the replay tokens and "Expert" prize).

Much of the project's time and energies have been taken up with the day to day tasks of collecting and developing the materials and data previously described. An additional objective, however, was to provide a mobile, audio-visual research exhibit with which learning and motivational variables related to instruction and communication in the public situation could be investigated. The specifications for several such devices were developed and three mobile audio-visual research units are to be delivered for use as mobile research laboratories in different locations in the Milwaukee museum. One of these devices is similar to the machine shown in Figure 4 except that it has greater flexibility for varying the consequences which can occur in relation to correct and incorrect responses. Two additional units, which can use ordinary 2 x 2 slides coordinated with audio, has as many as 18 separate modes which can be coded on the audio tape to control audio, advance of slides, question modes, feedback, scoring, and auxilliary devices for each frame. All coding and programming of the machine's actions are by tape signals and can be varied for each frame. For example, a visitor could be given audio instructions with several introductory frames, followed by a set of pretest questions without feedback, followed by any number of exposition frames intermixed with teaching frames, audio comments on answers, etc. and end with a posttest. Coding, frame sequencing, contingencies, etc. can all be easily changed as needed. Frames are projected by a Kodak Carrousel and the visual material and programs can be replaced simply by changing the slide tray and a cassette. There are options for scoring or not scoring each question for the player, and there is the possibility for branching and skipping. Built-in print out recorders provide permanent records of all visitor responses.[22] There is provision for the addition of a super-8 motion picture projector on a parallel screen which can also be coordinated by tape signals.

Based on the three years of the project, some closing general recommendations:

1. Museum staff responsible for the design and development of exhibits for the general public would, we believe, do well to devote serious time and effort to the task of specifying instructional objectives for their exhibits which can be measured in terms of tests of visitor performance. It is important to specify what the visitor should be able to do when he demonstrates that he has "learned" something from an exhibit. Defining instructional objectives usually includes: (a) the specification of what the

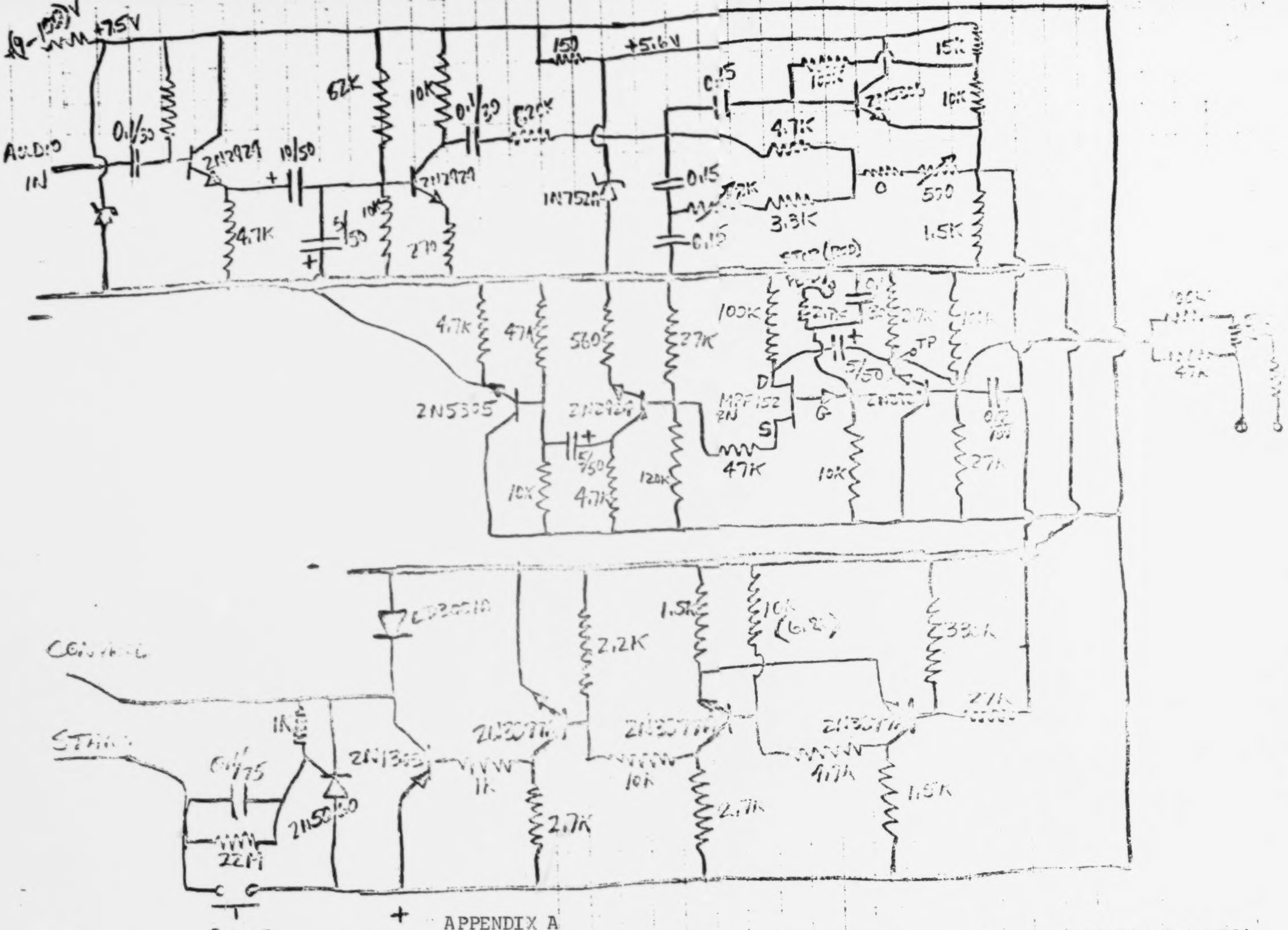
learner (or visitor) is expected to do as the result of exposure to the exhibit (e.g., compare, solve, list, etc.), (b) the specific conditions, if any, under which this behavior must occur, and (c) a statement of the minimum performance which is to be accepted (percent of total items correct, etc.)[23]. Knowing such objectives is not only important for the design of the exhibit system, but it is essential for evaluating its success. (See Paulson & Nelson, 1969, Saslow, 1970, Mager, 1962))

2. The highest priority should be given to further research development of practical means for monitoring the museum visitor and what has been communicated to him. If the exhibit objective is to develop the ability to distinguish between pairs of early Roman and Grecian pottery, the visitor should be able to exhibit this ability to make such distinctions during or after exposure to the exhibit,ppreferably as an integral part of his normal exploratory activity at the museum, with his performance unobtrusively recorded for later analysis. Our Milwaukee project has illustrated some of the possibilities; much work still needs to be done and alternative methods investigated.

3. While we have emphasized in this Report the importance of the "responsive" exhibit system,[18] push buttons, or questions placed at displays do not necessarily constitute an effective exhibit. We would, therefore, warn exhibit planners against the careless use of buttons and gadgets in order to provide responses for visitors. Pressing a button for an "effect" (often seen in Science museums) will not necessarily convey anything useful. It may help only if the viewer must first look to relevant exhibit features to find out which of several buttons to press. The correct button must then produce different feedback (e.g., advance a tape, produce a green light) from incorrect buttons. If the viewer can "play gadgets without looking or understanding, the gadgets are unlikely to help. But, to be sure that a visitor "sees" what you want him to "see," it is a great help to ask him to do something, the effect of which requires that he has in fact seen it. Buttons are sometimes convenient means of doing this. But we would discourage their use unless they do perform this function.

4. Museum administrators should find ways of encouraging their staff--especially those staff who work at planning and preparing exhibits for the public--to practice a more directly empirical and experimental approach to

their displays, including serious efforts to find out what visitors actually *do*, or can do, after they have been exposed to the efforts of these designers. Becoming familiar with some of the basic concepts and procedures in the learning systems field presented in such readings as Mager (1962), Banathy (1968), Epsich and Williams (1967), Skinner (1968) and others, would be an important first step in this direction.


9-15V
+7.5V
AUDIO IN
0.1/30
2N2929
10/50
4.7K
5/50
62K
10K
270
0.1/30
150
+5.6V
1N752A
0.15
4.7K
3.3K
0
500
1.5K
15K
10K
2N5305
STOP (RED)
100K
27K
TP
5/50
MPF152 2N
D
G
S
47K
10K
27K
4.7K
47K
560
2N5305
2N2929
10K
4.7K
120K
47K
CONTROL
START
START PB
1K
0.1/75
22M
2N1302
2N1520
1K
2.7K
2.2K
1.5K
10K
2.7K
47K
1.5K
330K
27K
47K
+
-

APPENDIX A

Tone-control circuit for use with the Norelco-Cassette "Carrycorder"(Model 150). A 68 cycle tone recorded on the tape by the vacillator circuit will stop the tape automatically. Regular voices and sounds above 68 cycles do not stop the tape.

APPENDIX B

General Notes Referred From Text

1. In order to operate the cassette in an audio-only mode, without the punchboard, and to allow the visitor to advance the tape at his own pace, the start/stop tone circuit is also available in a separate small box (about 1x1-1/2x3 in.). The visitor may easily carry this box and, by pressing the small button (see Figure 20), the tape will automatically start after it has stopped.

2. Use of the individual cassette also has other advantages. It opens up the possibility of individualizing cassette materials, adapting scripts to specific age groups, ethnic groups, interests, etc. Some exploratory work during the project used children's voices to talk to children, male and female voices, special character voices, etc. In our own studies, we found that such special treatment was unnecessary for our purposes and, therefore, audio scripts were kept the same for all visitors. Self-paced audio, using the manual advance button described in Note 1 (above) has interesting possibilities for providing individualized guided tours. A tape could be designed to cover a specific subject matter area involving, perhaps, several different exhibits separated from one another. The tape could "talk" the visitor through the exhibit area, automatically stopping at frequent points to allow observations to take place and consider the topics being discussed. For younger visitors, figures within the exhibits could talk to the visitor about himself, his life, his period, his tools, his problems, etc. The same exhibit could be treated through the eyes and voices of the curator, artists, and others who took a direct part in putting the exhibit together. Or, cassettes could include a walking tour by several knowledgeable persons conversing about the exhibits to one another with the visitor "listening in." The self-paced start/stop feature of the cassette would allow each visitor to pace his tour as he wishes. While we were not able to investigate some of these possibilities during the period of the project, the audio system capable of testing such an approach is completed and will be a part of the ongoing investigations in the museum.

3. To discourage playing with the projector by stepping on and off the foot pad, a timer kept the projector on for about 40 seconds after a visitor stepped off the pad; this served effectively to discourage most persons from such actions.

4. Manufactured by Nutting Industries, Ltd., 3404 North Holton Street, Milwaukee, Wisconsin 53212.

5. Manufactured by Behavior Controls Corporation, 1506 West Pierce Street, Milwaukee, Wisconsin 53204.

6. The improvement, however, was of only borderline significance.

7. The most common criticism by the visitors of the test situation was the absence of feedback on the questions and the lack of knowing their final score.

8. Exhibit conditions were never changed during any one day. If more than 48 Ss were completed before the end of the test day, data continued to be collected until the end of the day. Hence, the sizes of the groups under the different exhibit conditions tend to vary.

10.

Source	SS	d.f.	MS	F	p
Treatment	620.52	3	206.84	21.82	$<.001$
Error	1867	197	9.48		

9. It was originally planned to use the self-paced audio system (see Note 1 and Fig. 20) with an automatic stop after each question to be restarted by pressing the advance button. However, the tone control circuit was not operating properly during this period and, therefore, a 5-second pause was substituted. During preliminary tryouts of the audio-only condition during which the audio-only condition was compared with use of a 5-second pause, no differences were obtained on posttest performance. The taped-paced audio, using the 5-second silence following each question was, therefore, considered an acceptable substitute.

11. Due to the higher entering knowledge of visitors on the animism-shamanism topic, we could not find 10 unambiguous questions on which there were less than 30% correct answers on pretesting. Therefore, the rejection criterion had to be raised to 40%.

12. Only 176 of the 226 Ss are included in the pretest because the 50 Ss in the E(NP) group did not take a pretest.

13. The commercially available machine is the Model 306, coin-operated quiz game, manufactured by Nutting Industries, Ltd., 3404 North Holton Street, Milwaukee, Wisconsin 53212.

14. Questions are presented on a continuous 35-mm. film loop which can hold up to 6,000 separate frames. Each frame is individually coded to indicate which choice is correct, whether or not the frame is a question frame or an information frame, and whether or not the game is to continue or stop. Therefore, the length of the quiz sequence can be made as long as desired. However, since the scoring system only goes to 1200, the effective limit is no more than 12 questions (at 100 points per question), or 24 questions (at 50 points per question).

15. Normally, this cut-off score level would be established at the likely minimal level which most persons could be expected to achieve as the result of minimal effort during their visit to the reference exhibit. The 250-point level used here was our tentative estimate of this level.

16. A special circuit was provided in the devices so that the visitor may turn on the machine's projector light by touching the metal edge of the machine. This light makes visible on the screen the instructions for the game. If the visitor does not play, the projector light goes off again after about 20 seconds.

17. Removing feedback to specific questions (colored lights, scoring, etc.) would have the advantages of making ultimate performance more dependent on studying the exhibit and making the machine less threatening to those persons (which apparently includes many adult visitors) concerned with a possible public display of their ignorance. A possible difficulty with removing all such feedback, however, might be the loss of interest in playing. As noted earlier, one of the most common criticisms of the pre-posttest situation at the Skull exhibit was the absence of feedback or knowledge of final score during testing. This might be reduced somewhat by continuing to present the free-play tokens for performance above a minimum level and the ultimate EXPERT medal, although the player would not know for sure whether he had achieved the necessary level until he actually received the token or medal.

18. A responsive exhibit system is one in which the viewer not only simply "looks" at something, but he is able to respond in some manner to what he thinks he sees or understands and, after responding, receives feedback about his response and, perhaps, some new things to look at, think about, and respond to. Responding of some sort is important because the actions necessary to answer a well designed question directs the viewer to those features we wish him to notice and which are the link in the new learning to be developed.

19. If the objectives are to be presented in other than a test format, the problem would probably be in obtaining a careful reading. As is well known, persons do not ordinarily read instructions, labels, etc. The particular advantage of placing the exhibit objectives in test form is that it requires answers to questions and secures more attention to each bit of information in step form.

20. There are various commercially available systems which might be used for such purposes. There are various types of especially treated answer sheets on which the person answers, for example, by erasing an overlay over his choice and can tell from the number which becomes visible underneath whether or not he was correct, by marking the choice with a pen which,

through an invisible chemical, provides different colors for right and wrong answers. There are relatively simple electromechanical answering devices which could also be used in this manner. Dr. Harvey White at Berkeley has developed and tested several response devices for museum use.

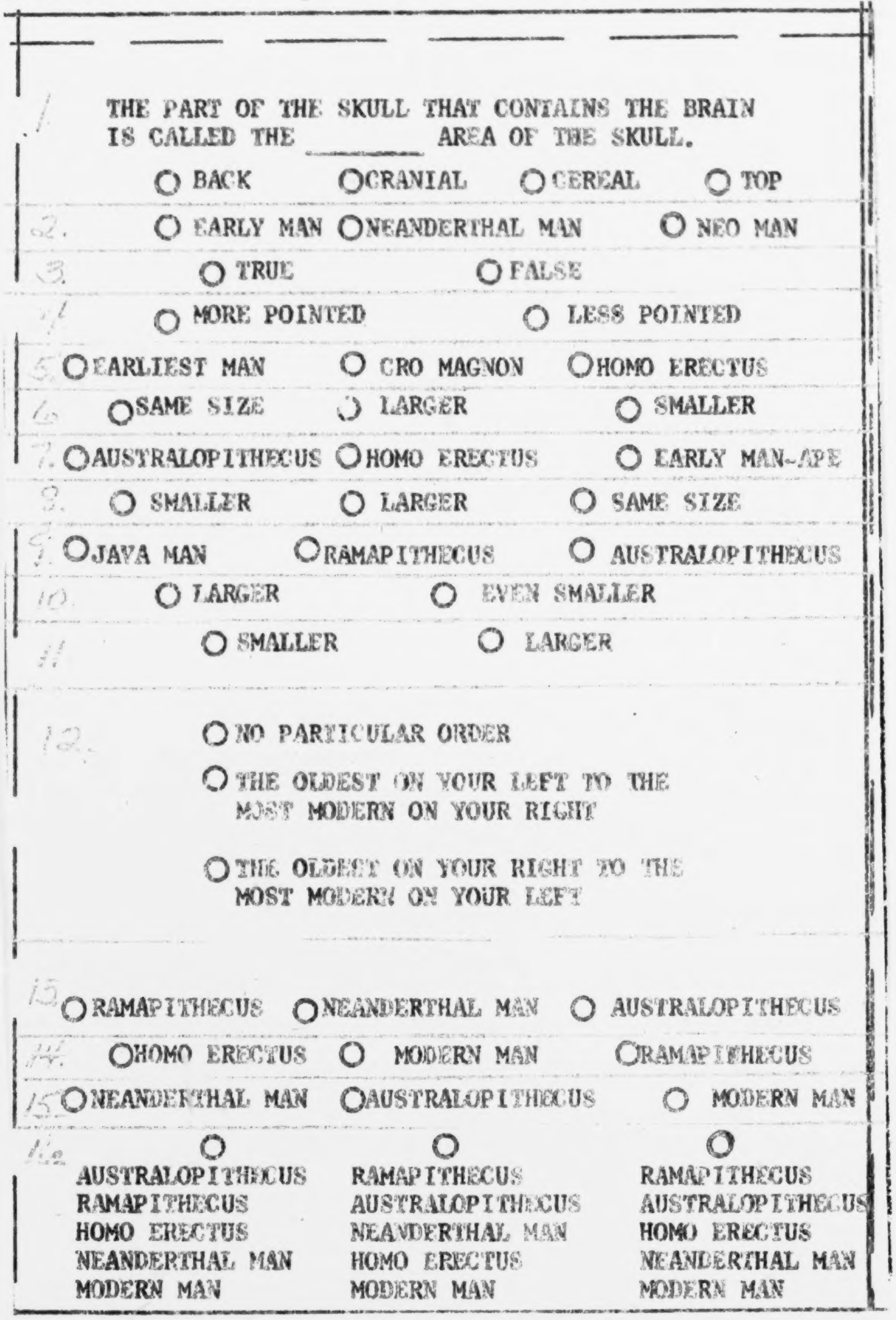
21. Called the QRS Responder, manufactured by Quick Response Systems, 800 North West Street, Alexandria, Virginia 22314, which is described in a later section of this chapter. Some models use corrective feedback; others advance on every answer, but can be used for testing, since the holes punched in the card can later be counted.

23. For a more detailed analysis of instructional objectives, see Mager (1962), Gagne (1965), and Payne (1968).

22. This device, Model 311C, is manufactured by Nutting Industries, Ltd. of Milwaukee, and was developed for another client by the manufacturer and modified for public access use for this project. Modifications have included provision for coin-token operation, token dispensers contingent on score, and a read-out counter.

APPENDIX C

Following are the final 16 questions on the Skull program, as they appeared on the single program sheet used on the punchboard. Each question was accompanied by the audio-script for the M-Condition given on the next page.



1. THE PART OF THE SKULL THAT CONTAINS THE BRAIN IS CALLED THE ________ AREA OF THE SKULL.
○ BACK ○ CRANIAL ○ CEREAL ○ TOP

2. ○ EARLY MAN ○ NEANDERTHAL MAN ○ NEO MAN

3. ○ TRUE ○ FALSE

4. ○ MORE POINTED ○ LESS POINTED

5. ○ EARLIEST MAN ○ CRO MAGNON ○ HOMO ERECTUS

6. ○ SAME SIZE ○ LARGER ○ SMALLER

7. ○ AUSTRALOPITHECUS ○ HOMO ERECTUS ○ EARLY MAN-APE

8. ○ SMALLER ○ LARGER ○ SAME SIZE

9. ○ JAVA MAN ○ RAMAPITHECUS ○ AUSTRALOPITHECUS

10. ○ LARGER ○ EVEN SMALLER

11. ○ SMALLER ○ LARGER

12. ○ NO PARTICULAR ORDER
○ THE OLDEST ON YOUR LEFT TO THE MOST MODERN ON YOUR RIGHT
○ THE OLDEST ON YOUR RIGHT TO THE MOST MODERN ON YOUR LEFT

13. ○ RAMAPITHECUS ○ NEANDERTHAL MAN ○ AUSTRALOPITHECUS

14. ○ HOMO ERECTUS ○ MODERN MAN ○ RAMAPITHECUS

15. ○ NEANDERTHAL MAN ○ AUSTRALOPITHECUS ○ MODERN MAN

16.

○	○	○
AUSTRALOPITHECUS RAMAPITHECUS HOMO ERECTUS NEANDERTHAL MAN MODERN MAN	RAMAPITHECUS AUSTRALOPITHECUS NEANDERTHAL MAN HOMO ERECTUS MODERN MAN	RAMAPITHECUS AUSTRALOPITHECUS HOMO ERECTUS NEANDERTHAL MAN MODERN MAN

APPENDIX C

1. Audio script, M-Condition, used with question sheet on previous page.

We're going to find out about the Age of Man exhibit. Look at the panels in front of you. There are many skulls on the panels and they aren't all the same! Some are different from others. The skulls that we're going to talk about have large white letters above their heads. Look at the panel farthest to your right. The skull on that panel has the large white letter A above it. That's the skull of Modern Man, the kind of skull that people have today. Take a close look at Modern Man's skull. The back of his skull and the part that is above the jawbone, and in back of the eyes, is the part that contains the brain. That is called the cranial area of the skull. Now answer question 1 on your answer sheet. ‡

Good! The part of the skull that holds the brain is called the cranial area of the skull. That's the back of the skull and the part that's above the jawbone and behind the eyes. Take a good look at Modern Man's skull. The cranial area of Modern Man's skull is large and makes up a big part of the skull. Now look at the panel just to the left of Modern Man. That panel has a skull with a large white letter B above it. The name of this skull is in large white letters at the top of the panel. What is his name? In question 2, name skull B. ‡

Right! This is the skull of Neanderthal Man, Modern Man's most recent ancestor. Neanderthal Man was the first form of man to have a brain of Modern size. Since his brain was the same size as that of Modern Man, what does that tell you about his cranial area? Compare the skull of Neanderthal Man with that of Modern Man. Do their cranial areas differ very greatly in size? Look closely at these skulls and listen very carefully because here comes question number 3. Is this statement true or false? Since Neanderthal Man's brain was about the same size as that of Modern Man, his cranial area must also be almost as large as that of Modern Man.

You're right! The cranial areas of Neanderthal Man and Modern Man are about the same size. Their cranial areas are the same size because Neanderthal Man's brain was about the same size as that of Modern Man. Even though Neanderthal Man's skull is almost as large as that of Modern Man, it is shaped a little differently. Take a close look at the shape of Neanderthal Man's cranial area. Compare it with that of Modern Man.

Do you notice any difference in the way the backs of their skulls are shaped? Look at the skulls of Neanderthal Man and Modern Man carefully and answer question 4. Is the back of Neanderthal Man's skull more pointed or less pointed than that of Modern Man?

Right! It is more pointed. Knowing that the cranial area of Neanderthal Man's skull is both pointed in back as well as large in size are good ways to tell his skull apart from the others. Now look at the panel to the left of Neanderthal Man. That is the one that has the skull with the large white letter C over it. The name of that skull is in large white letters at the top of the panel. That is the skull of Earliest Man. But there is a better, more scientific name for this skull in small white letters under Earliest Man. To answer question 5, find his scientific name.

Good! The scientific name for Skull C is Homo Erectus. Homo Erectus is an older form of man than Neanderthal Man and his brain was smaller than that of Neanderthal Man. Compare the skulls of Homo Erectus and Neanderthal Man. Look closely at their cranial areas. Do they differ in size? Compare the skulls and answer question 6. Is the cranial area of Homo Erectus the same as Neanderthal Man, larger, or smaller than that of Neanderthal Man?

That's right. Since Homo Erectus is an older form of man with a smaller brain than that of Neanderthal Man, his cranial area is smaller than that of Neanderthal Man. Take another look at the skulls of Homo Erectus and Neanderthal Man. Look closely at the shapes of their cranial areas. Do you see the way the backs of their skulls are shaped? Notice that the back of the skull of Home Erectus is even more pointed than that of Neanderthal. Now we know that the skull of Homo Erectus is both smaller in size and a little more pointed in back than that of Neanderthal Man. Look at the panel to the left of Homo Erectus. The skull on that panel has a large white letter D above it. The large white letters at the top of the panel tell you that this is the skull of Near Man. But just like the skull of Homo Erectus, there is a better, more scientific name for Skull D than Near Man. To answer question 7, find the scientific name for Skull D.

Good! The scientific name for skull D is Australopithecus. Try to pronounce that. Australopithecus. Australopithecus is a very old ancestor of man who lived even before Homo Erectus. Look at the exhibit. We're going to compare two skulls again. This time we will compare the cranial area of Australopithecus, the older skull, with that of Homo Erectus, the more recent skull. Look closely at the skulls of Australopithecus and Homo Erectus in the exhibit. In question 8, is the cranial area of Australopithecus smaller than that of Homo Erectus, larger, or the same size as that of Homo Erectus?

Great! You got it right. Australopithecus is older than Homo Erectus, therefore, his brain was smaller, and Australopithecus had a smaller cranial area than that of the more recent skull, Homo Erectus.

Now let's look at the panel to the left of the skull of Australopithecus. This is the panel farthest to the left in the exhibit. Notice that there is no actual skull on that panel, just the outline of a skull with the large letter E above it. In question 9, find the scientific name for skull E. ‡

Good! The scientific name of skull E is Ramapithecus. Ramapithecus is the oldest ancestor of man in the exhibit. He lived over 14 million years ago, and his skull would be older than the skull of Australopithecus, but he lived so long ago that only a few bone fragments of Ramapithecus have ever been found. The drawing of the skull on the panel is what we think he looked like. Compare the drawing of Ramapithecus with the skull of his closest but more recent relative, Australopithecus. If we actually had a skull of Ramapithecus to compare with that of Australopithecus, how do you think their cranial areas would differ? In question 10, should the cranial area of Ramapithecus be larger or even smaller than that of Australopithecus? ‡

Right! Ramapithecus is older than Australopithecus and, therefore, his cranial area should be smaller. Look at all the skulls in the exhibit and listen carefully, because here comes question 11. In general, does a more recent skull have a smaller or a larger cranial area than that of an older skull? ‡

Very good! More recent forms of man had large brains and, therefore, larger cranial areas than older ancestors of man. Look carefully at all the skulls in the exhibit. Do you see how they are arranged? In question 12, find the order in which the skulls are arranged. ‡

That's right! The skulls in the exhibit are arranged in order from the oldest on your left to the most modern on your right. For the next few questions, try to remember the scientific names of the skulls without looking up at the names on the panels. In question 13, **name** the skull that is older than Modern Man, but more recent than Homo Erectus. ‡

Good! Neanderthal Man came between Homo Erectus and Modern Man. Look closely at the exhibit. Find the skulls of both Australopithecus and Neanderthal Man. In question 14, name the skull that is older than Neanderthal Man, but more recent than Australopithecus. ‡

You're right. The answer is Homo Erectus. You can tell Home Erectus is older than Neanderthal Man and more recent than Australopithecus because he has a smaller cranial area than Neanderthal Man, but a larger cranial area than that of Australopithecus. This time, in question 15, name the skull that comes between Ramapithecus and Homo Erectus. ‡

That's right. Australopithecus comes between Ramapithecus and Homo Erectus. Now for one final question see if you can remember both the names of the skulls and their ages. To answer question 16, poke the hole over the list that correctly names the skulls in order from the oldest at the top of the list, to the most modern at the bottom. ‡

Great! You did very well, Now take your machine and answer sheet back to the attendant. Thank you for taking the program. ‡

APPENDIX C (CONT.)

2. Audio used under AQ Condition, with 5-second pauses (dots) following each question. The punchboard question sheet was not used.

We're going to find out about the Age of Man exhibit. Look at the panels in front of you. There are many skulls on the panels and they aren't all the same: Some are different from others. The skulls that we're going to talk about have large white letters above their heads. Look at the panel farthest to your right. The skull on that panel has the large white letter A above it. That's the skull of Modern Man, the kind of skull that people have today. Take a close look at Modern Man's skull. The back of his skull and the part that is above the jawbone, and in back of the eyes, is the part that contains the brain. That is called the cranial area of the skull. Now answer this question: what is the name of the part of the skull that contains the brain? ...

The part of the skull that holds the brain is called the cranial area of the skull. That's the back of the skull and the part that's above the jawbone and behind the eyes. Take a good look at Modern Man's skull. The cranial area of Modern Man's skull is large and makes up a big part of the skull. Now look at the panel just to the left of Modern Man. That panel has a skull with a large white letter B above it. The name of this skull is in large white letters at the top of the panel. What is his name? Name skull B. ...

This is the skull of Neanderthal Man, Modern Man's most recent ancestor. Neanderthal Man was the first form of man to have a brain of Modern size. Since his brain was the same size as that of Modern Man, what does that tell you about his cranial area? ... Compare the skull of Neanderthal Man with that of Modern Man. Do their cranial areas differ very greatly in size? ... Look closely at these skulls and listen very carefully because here comes another question. Is this statement true or false? Since Neanderthal Man's brain was about the same size as that of Modern Man, his cranial area must also be almost as large as that of Modern Man. ...

The cranial areas of Neanderthal Man and Modern Man are about the same size. Their cranial areas are the same size because Neanderthal Man's brain was about the same size as that of Modern Man. Even though Neanderthal Man's skull is almost as large as that of Modern Man, it is shaped a little differently. Take a close look at the shape of

Neanderthal Man's cranial area. Compare it with that of Modern Man. Do you notice any difference in the way the backs of their skulls are shaped? Look at the skulls of Neanderthal Man and Modern Man carefully and answer this question, Is the back of Neanderthal Man's skull more pointed or less pointed than that of Modern Man?

It is more pointed. Knowing that the cranial area of Neanderthal Man's skull is both pointed in back as well as large in size are good ways to tell his skull apart from the others. Now look at the panel to the left of Neanderthal Man. That is the one that has the skull with the large white letter C over it. The name of that skull is in large white letters at the top of the panel. That is the skull of Earliest Man. But there is a better, more scientific name for this skull in small white letters under Earliest Man. Find his scientific name. ...

The scientific name for skull C is Homo Erectus. Homo Erectus is an older form of man than Neanderthal Man and his brain was smaller than that of Neanderthal Man. Compare the skulls of Homo Erectus and Neanderthal Man. Look closely at their cranial areas. Do they differ in size? Compare the skulls and answer this question. Is the cranial area of Homo Erectus the same as Neanderthal Man, larger, or smaller than that of Neanderthal Man?

Since Homo Erectus is an older form of man with a smaller brain than that of Neanderthal Man, his cranial area is smaller than that of Neanderthal Man. Take another look at the skulls of Homo Erectus and Neanderthal Man. Look closely at the shapes of their cranial areas. Do you see the way the backs of their skulls are shaped? ... Notice that the back of the skull of Homo Erectus is even more pointed than that of Neanderthal. Now we know that the skull of Homo Erectus is both smaller in size and a little more pointed in back than that of Neanderthal Man. Look at the panel to the left of Homo Erectus. The skull on that panel has a large white letter D above it. The large white letters at the top of the panel tell you that this is the skull of Near Man. But just like the skull of Homo Erectus, there is a better, more scientific name for skull D than Near Man. Find the scientific name for skull D. ...

The scientific name for skull D is Australopithecus. Try to pronounce that. Australopithecus. Australopithecus is a very old ancestor of man who lived even before Homo Erectus. Look at the exhibit. We're going to compare two skulls again. This time we will compare the cranial area of Australopithecus, the older skull, with that of Homo Erectus, the more recent skull. Look closely at the skulls of Australopithecus and Homo Erectus in the exhibit. Is the cranial area of Australopithecus smaller than that of Homo Erectus, larger, or the same size as that of Homo Erectus? ...

Australopithecus is older than Homo Erectus, therefore, his brain was smaller, and Australopithecus had a smaller cranial area than that of the more recent skull, Homo Erectus. ...

Now let's look at the panel to the left of the skull of Australopithecus. This is the panel farthest to the left in the exhibit. Notice that there is no actual skull on that panel, just the outline of a skull with the large letter E above it. Find the scientific name for skull E. ...

The scientific name of skull E is Ramapithecus. Ramapithecus is the oldest ancestor of man in the exhibit. He lived over 14 million years ago, and his skull would be older than the skull of Australopithecus. But he lived so long ago, that only a few bone fragments of Ramapithecus have ever been found. The drawing of the skull on the panel is what we think he looked like. Compare the drawing of Ramapithecus with the skull of his closest but more recent relative, Australopithecus. If we actually had a skull of Ramapithecus to compare with that of Australopithecus how do you think their cranial areas would differ? Should the cranial area of Ramapithecus be larger or even smaller than that of Australopithecus? ...

Ramapithecus is older than Australopithecus and therefore his cranial area should be smaller. Look at all of the skulls in the exhibit and listen carefully, because here comes another question. In general, does a more recent skull have a smaller or a larger cranial area than that of an older skull? ...

More recent forms of man had large brains and therefore larger cranial areas than older ancestors of man. Look carefully at all the skulls in the exhibit. Do you see how they are arranged? Find the order in which the skulls are arranged....

The skulls in the exhibit are arranged in order from the oldest on your left to the most modern on your right. For the next few questions try to remember the scientific names of the skulls without looking up at the names on the panels. Name the skull that is older than Modern Man but more recent than Homo Erectus. ...

Neanderthal Man came between Homo Erectus and Modern Man. Name the skull that is older than Neanderthal Man but more recent than Australopithecus. ...

The answer is Homo Erectus. You can tell Homo Erectus is older than Neanderthal Man and more recent than Australopithecus because he has a smaller cranial area than Neanderthal Man but a larger cranial area than that of Australopithecus. This time, name the skull that comes between Ramapithecus and Homo Erectus. ...

Australopithecus comes between Ramapithecus and Homo Erectus. Now for one final question. See if you can remember both the names of the skulls and their ages. Try to name them in order starting with the oldest. ...

Ramapithecus, the skull farthest to your left, is the oldest. Then came Australopithecus, Homo Erectus, Neanderthal Man, and finally Modern Man, the most recent skull. This concludes our program on the Age of Man Exhibit. Please take your machine back to the attendent. Thank you for taking our program.

3. Audio used under AQ(w) Condition. Same as above, except that there were no pauses between questions (dots) in above script.

APPENDIX C (CONT.)

4. Audio-Narration, AN Condition. Questions were removed and script read as narrative.

We're going to find out about the Age of Man exhibit. Look at the panels in front of you. There are many skulls on the panels and they aren't all the same! Some are different from others. The skulls that we're going to talk about have large white letters above their heads. Look at the panel farthest to your right. The skull on that panel has the large white letter A above it. That's the skull of Modern Man, the kind of skull that people have today. Take a close look at Modern Man's skull. The back of his skull and the part that is above the jawbone, and in back of the eyes, is the part that contains the brain. That is called the cranial area of the skull. ...

Remember, the part of the skull that holds the brain is called the cranial area of the skull. Take a good look at Modern Man's skull. The cranial area of Modern Man's skull is large and makes up a big part of the skull. Now look at the panel just to the left of Modern Man. That panel has a skull with a large white letter B above it. The name of this skull is in large white letters at the top of the panel. ...

This is the skull of Neanderthal Man, Modern Man's most recent ancestor. Neanderthal Man was the first form of man to have a brain of Modern size. Since his brain was the same size as that of Modern Man, what does that tell you about his cranial area? ... Compare the skull of Neanderthal Man with that of Modern Man. Do their cranial areas differ very greatly in size? ... Look closely at these skulls and listen very carefully. ...

The cranial areas of Neanderthal Man and Modern Man are about the same size. Their cranial areas are the same size because Neanderthal Man's brain was about the same size as that of Modern Man. Even though Neanderthal Man's skull is almost as large as that of Modern Man, it is shaped a little differently. Take a close look at the shape of Neanderthal Man's cranial area. Compare it with that of Modern Man. Do you notice any difference in the way the backs of their skulls are shaped? Look at the skulls of Neanderthal Man and Modern Man carefully. The back of Neanderthal Man's skull is more pointed. Knowing that the cranial area of Neanderthal Man's skull is both pointed in back as well as large in size are good ways to tell his skull apart from the others. Now look at the panel to the left of Neanderthal Man. That is the one that has the skull with the large white letter C over it. The name of that skull is in large white letters at the top of the panel. That is the skull of Earliest Man. But there is a better, more scientific name for this skull in small white letters under Earliest Man. ...

The scientific name for skull C is Homo Erectus. Homo Erectus is an older form of man than Neanderthal Man and his brain was smaller than that of Neanderthal Man. Look closely at the size of their cranial areas. ...

Since Homo Erectus is an older form of man with a smaller brain than that of Neanderthal Man, his cranial area is smaller than that of Neanderthal Man. Look closely at the shapes of their cranial areas. Do you see the way the backs of their skulls are shaped? ... Notice that the back of the skull of Homo Erectus is even more pointed than that of Neanderthal. Now we know that the skull of Homo Erectus is both smaller in size and a little more pointed in back than that of Neanderthal Man. Look at the panel to the left of Homo Erectus. The skull on that panel has a large white letter D above it. The large white letters at the top of the panel tell you that this is the skull of Near Man. But just like the skull of Homo Erectus, there is a better, more scientific name for skull D than Near Man. ...

The scientific name for skull D is Australopithecus. Try to pronounce that. Australopithecus. Australopithecus is a very old ancestor of man who lived even before Homo Erectus. Look at the exhibit. We're going to compare two skulls again. This time we will compare the cranial area of Australopithecus, the older skull, with that of Homo Erectus, the more recent skull. Look closely at the size of the skulls of Australopithecus and Homo Erectus in the exhibit. ...

Australopithecus is older than Homo Erectus, therefore, his brain was smaller, and Australopithecus had a smaller cranial area than that of the more recent skull, Homo Erectus. ...

Now let's look at the panel to the left of the skull of Australopithecus. This is the panel farthest to the left in the exhibit. Notice that there is no actual skull on that panel, just the outline of a skull with the large letter E above it. ...

The scientific name of skull E is Ramapithecus. Ramapithecus is the oldest ancestor of man in the exhibit. He lived over 14 million years ago, and his skull would be older than the skull of Australopithecus. But he lived

APPENDIX D

Following is the list of criterion questions and other instructions as they appeared on the MTA Pre-Postest Machine in the Hall of Religion. Each question appeared, one at a time, in the viewing window of the test machine (see Figure 6). A floor pad switch in front of the machine activated a circuit so that picking up the phone would initiate the audio instructions and subsequent events (see text). The statement "Please pick up the phone for quiz instructions" remained in the viewing window between plays. Leaving the machine during the quiz, after a short delay, reset the program to its beginning (the instructions to pick up the phone).

PLEASE PICK UP THE PHONE FOR QUIZ INSTRUCTIONS.

WHAT IS YOUR AGE?
- A. 10 years or less
- B. 11-13
- C. 14-18
- D. 19 years or over

HOW MANY GRADES OF SCHOOLING HAVE YOU COMPLETED?
- A. 6 grades or less
- B. 7-9
- C. 10-12
- D. 1 or more years of college

AN EXAMPLE OF ANIMISM WOULD BE:
- A. The belief that the sun and the moon have spirit power
- B. Belief in a single supreme being
- C. Denial of the spirit world
- D. Obeying the rules of the church

WHAT IS A FUNCTION OF A SHAMAN?
- A. Weave ceremonial robes
- B. Bury the dead
- C. Prepare medicinal herbs
- D. Control the spirits

ASTROLOGY IS:
- A. Astronomy made simple
- B. A new means of communicating with the spirits
- C. A Corruption of religious beliefs
- D. A form of divining the future

DIVINATION TECHNIQUES ARE:
- A. No longer in existence
- B. Almost extinct except for some primitive tribes
- C. Still popular in many areas
- D. A new fad

MEMBERS OF THE FALSE FACE SOCIETY ARE:
- A. Monotheistic
- B. Animistic
- C. Atheistic
- D. Anti-theistic

WHICH OF THE FOLLOWING CAN BE USED AS A MEANS OF DIVINATION?
- A. Tea leaves
- B. Playing cards
- C. Shells
- D. All of the above

THE FALSE FACE SOCIETY IS A PART OF THE RELIGIOUS TRADITION OF THE:
- A. Hopi Indians
- B. Pueblo Indians
- C. Iroquois Indians
- D. Menominie Indians

INDIAN "HOW AND WHY" STORIES TOLD ABOUT:
- A. Hunting and fishing
- B. Relationships between nature, wildlife, and people
- C. Arts and Crafts
- D. The heroics of the Chief

WHAT IS THE LEADER OF SPIRIT WORKSHOP CEREMONIES CALLED?
- A. Chief
- B. Head Man
- C. Shaman
- D. Spiritual Leader

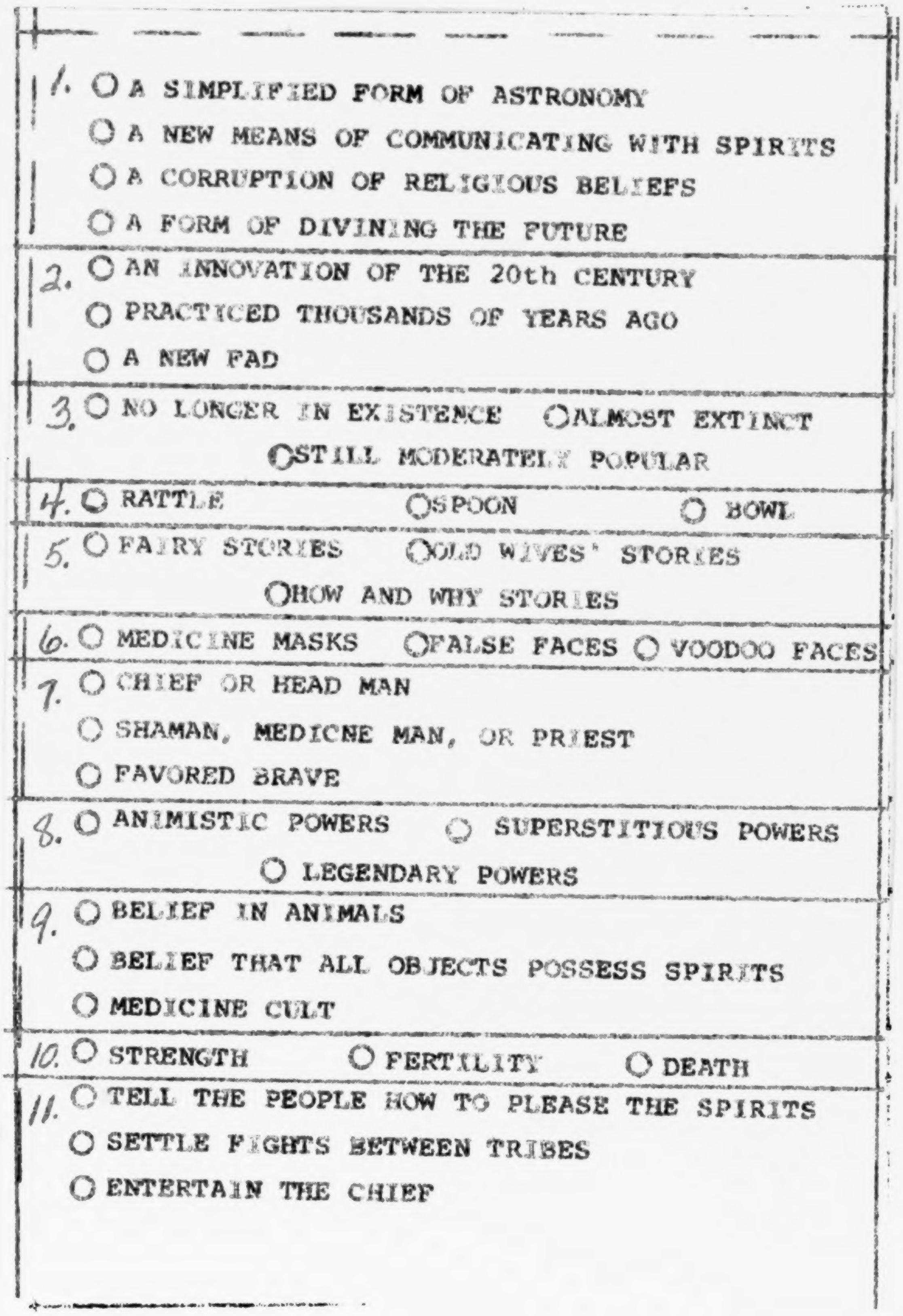
THE RELATIONSHIP BETWEEN ANIMISM AND SHAMINISM IS SUCH THAT:
- A. Shamanism is necessary for animism
- B. Animism is necessary for shamanism
- C. One always goes with the other
- D. There is no relationship between the two.

YOU'VE FINISHED THE QUIZ NOW.

THANK YOU.

APPENDIX E

The final 11 question sheet used with the punchboard with the animism program at the Hall of Religion. (For accompanying audio script, see next page.)



1. ○ A SIMPLIFIED FORM OF ASTRONOMY
○ A NEW MEANS OF COMMUNICATING WITH SPIRITS
○ A CORRUPTION OF RELIGIOUS BELIEFS
○ A FORM OF DIVINING THE FUTURE

2. ○ AN INNOVATION OF THE 20th CENTURY
○ PRACTICED THOUSANDS OF YEARS AGO
○ A NEW FAD

3. ○ NO LONGER IN EXISTENCE ○ ALMOST EXTINCT
○ STILL MODERATELY POPULAR

4. ○ RATTLE ○ SPOON ○ BOWL

5. ○ FAIRY STORIES ○ OLD WIVES' STORIES
○ HOW AND WHY STORIES

6. ○ MEDICINE MASKS ○ FALSE FACES ○ VOODOO FACES

7. ○ CHIEF OR HEAD MAN
○ SHAMAN, MEDICNE MAN, OR PRIEST
○ FAVORED BRAVE

8. ○ ANIMISTIC POWERS ○ SUPERSTITIOUS POWERS
○ LEGENDARY POWERS

9. ○ BELIEF IN ANIMALS
○ BELIEF THAT ALL OBJECTS POSSESS SPIRITS
○ MEDICINE CULT

10. ○ STRENGTH ○ FERTILITY ○ DEATH

11. ○ TELL THE PEOPLE HOW TO PLEASE THE SPIRITS
○ SETTLE FIGHTS BETWEEN TRIBES
○ ENTERTAIN THE CHIEF

APPENDIX E (Cont'd.)

Final audio script to accompany above questions on animism program.

1. Audio script used with the punchboard (M Condition): 50-secs. of music (Age of Aquarius).

   I'm sure you've heard those lines before, And you probably know that they're referring to astrology. But do you know what astrology is. Look at the astrology magazines in case two, They're in the middle and near the front. Notice that label beneath them. The label says astrology is a form of divining the future. What is astrology? Answer question 1 by poking the hole in front of the answer that best describes astrology.‡

   That's right. Astrology is a form of divining the future. That means it is a way to predict the future--it's a type of fortune telling. But how long ago was it developed? Is it an innovation of the 20th century? Or was it practiced thousands of years ago? Or is it a new fad? For question 2, poke the phrase that tells how long ago astrology was developed.‡

   Right. Astrology is thousands of years old. It was first developed by the Chaldeans in 2,000 B.C. and has continued to exist up to the present time. Are there some other familiar divination or fortune telling techniques in this case? Look to the left of the astrology magazines. Playing cards, a crystal ball, and tea leaves are all items that are still used today to predict the future. Are divination techniques no longer in existence? Or are they practically extinct except for some primitive tribes? Or, are they still moderately popular in many areas? In question 3, find to what extent divination techniques are used today.‡

   Yes, many of the objects in this case are still used today to predict the future. In fact, those small wooden symbols on your right in the front of the case are quite popular as divining tokens in Southeast Asia today. There are also a lot of Indian items in this case that you might not be familiar with. Look at those Kwakiutl scallop shells in the middle of the case and read the label carefully. Question 4 is: what are these shells used for?‡

   They're used as a rattle by the Kwakiutl Indians in spirit worship ceremonies. Look at the top picture on the right side of the back wall. Like all other people the Indians were concerned with the relationship between nature, wildlife, and people; the relationship of human characteristics to living things. They told stories about these things they didn't understand. What are these stories called? Are they fairy stories, old wives' stories, or "how and why" stories? That's question 5 - what are these stories called?⩲

Right. They are called "how and why" stories because they explained the how and the why of things the Indians didn't really understand like rain, thunder, sickness, and death. They believed that spirits controlled all these things. Look at the rest of the pictures on the right side of the back wall. They show how the spirits were called upon for rain by the Hopi Indians as well as for prosperity and advice in war. Now look to the left of the pictures. See those red and orange wooden masks? The Iroquois Indians carved these masks from a living tree as a part of their religious custom. Look at the label next to these masks and see if you can find what they are called. In question 6, poke the hole in front of the correct name for these Iroquois masks.⩲

They are called False Faces and they are worn by the Iroquois Indians in ceremonies to drive away evil spirits. Every adult male Iroquois Indian was a member of the False Face Society. Each member of the False Face Society went alone into the forest and fasted until he had a vision of a spirit. He then carved the face of this spirit in a living tree, and later made a mask out of it. But, even though every member of the False Face Society wore a mask and took part in the ceremonies, only one member of the tribe was the leader of the ceremonies to drive away evil spirits. This was also true of other Indian tribes. Only one person was the leader of these ceremonies, and it was his job to control the spirits. Look at the exhibit title on the right side of the back wall. What is this leader called? Is he the Chief or head man? Is he the shaman, medicine man or priest? Or is he the favored brave? In question 7, find the name of the leader of the ceremonies.⩲

The leader is the medicine man, priest, or shaman and his job is to control the power of the spirits. This form of religion, where one person has the power to communicate with the spirits and tell his people what the wishes of these spirits are, is known as shamanism. And the leaders are shamans. So far we've been calling the powers that the shamans controlled spirit powers, but they have a fancier name. Look at the exhibit title again. Do you know what these powers are called? Are they called animistic powers, superstitious powers, or legendary powers? Answer question 8 by poking the answer that tells what these powers are called.⩲

Animistic powers are what they are called. And the shamans controlled these animistic powers so that the people didn't feel quite so helpless or frightened by them. But what exactly are these animistic powers and what does animism mean? Look at case 1 - on your left. This tells us about the form of religion known as animism. What is animism? Is it a belief in animals, a belief that all objects possess spirits, or a medicine cult? Question 9 is: What is animism?‡

Animism is the belief that all substances, objects, and phenomena possess spirits. Look at the objects in the upper right of this case. Can you see some of the things believed to have spiritual powers? Some of the best examples shown here of objects having spiritual qualities are the sun, the moon, the wind, and thunder. According to animistic beliefs everything is spiritual, even mountains. Look at the Japanese shrine on the upper left. It shows a mountain which the people believed was a spirit mountain. Remember the Iroquois False Face Society? Like many other Indian tribes, the Iroquois believed in many spirits, especially spirits of the forest like trees and animals, and spirits of nature like wind and thunder. The Iroquois religion, therefore, is based on the belief that all substances, objects, and phenomena possess spirits. What is this form of religion called? Answer question 10 by finding the correct name for the belief that all substances objects and phenomena possess spirits.‡

This belief that all substances, objects, and phenomena possess spirits is known as animism. Therefore, the Iroquois False Face society is animistic. According to animistic beliefs there are spirits in everything--both in good things like the sun and strength and in bad things like death. With all these spirits life could be pretty threatening and at times the people turned to shamans. How did the shamans help these people? Did they tell the people how to please the spirits, did they settle fights between tribes, or did they entertain the chief? Anawer question 11 by poking the choice that tells how the shamans helped the people.‡

The shamans told the people how to please the spirits. If the people pleased the spirits, the spirits would send rain or drive away sickness, or grant other wishes of the people. In this way animism helped the people to understand things in nature like rain and thunder and shamanism helped make them feel they had some control over these natural phenomena. They knew that if they were obedient and pleased the spirits, the spirits would be good to them.

This concludes your program on the Hall of Religion. Take your machine back to the attendant. Thank you very much for taking the program.‡

2. Audio script used without the punchboard but with questions (AQ(w))Condition). No pauses were used with the script. Therefore, no spaces are provided following questions. 50-secs. of music (Age of Aquarius).

I'm sure you've heard those lines before. And you probably know that they're referring to astrology. But do you know what astrology is? Look at the astrology magazines in case two. They're in the middle and near the front. Notice that label beneath them. The label says astrology is a form of divining the future. What is astrology? Astrology is a form of divining the future. That means it is a way to predict the future--it's a type of fortune telling. But how long ago was it developed? Astrology is thousands of years old. It was first developed by the Chaldeans in 2,000 B.C. and has continued to exist up to the present time. Are there some other familiar divination or fortune telling techniques in this case? Look to the left of the astrology magazines. Playing cards, a crystal ball, and tea leaves are all items that are still used today to predict the future. Are divination techniques no longer in existence? Or, are they still moderately popular in many areas? Yes, many of the objects in this case are still used today to predict the future. In fact, those small wooden symbols on your right in the front of the case are quite popular as divining tokens in Southeast Asia today. There are also a lot of Indian items in this case that you might not be familiar with. Look at those Kwakiutl scallop shells in the middle of the case and read the label carefully. What are these shells used for? They're used as a rattle by the Kwakiutl Indians in spirit worship ceremonies. Look at the top picture on the right side of the back wall. Like all other people the Indians were concerned with the relationship between nature, wildlife, and people; the relationship of human characteristics to living things. They told stories about these things they didn't understand. What are these stories called? They are called "how and why" stories because they explained the how and the why of things the Indians didn't really understand like rain, thunder, sickness, and death. They believed that spirits controlled all these things. Look at the rest of the pictures on the right side of the back wall. They show how the spirits were called upon for rain by the Hopi Indians as well as for prosperity and advice in war. Now look to the left of the pictures. See those red and orange wooden masks? The Iroquois Indians carved these masks from a living tree as a part of their religious custom. Look at the label next to these masks and see if you can find what they are called. They are called False Faces and they are worn by the Iroquois Indians in ceremonies to drive away evil spirits. Every adult male Iroquois Indian was a member of the False Face Society. Each member of the False Face Society went alone into the forest and fasted until he had a vision of a spirit. He then carved the face of this spirit in a living tree, and later made a mask out of it. But, even though every member of the False Face Society wore a mask and took part in the ceremonies, only one member of the tribe was the leader of the ceremonies to drive away evil spirits. This was also true of other Indian tribes. Only one person was the leader of these ceremonies, and it was his job to control the spirits. Look at the exhibit title on the right side of the back wall. What is this leader called? The leader is the medicine man priest, or shaman, and his job is to control the power of the spirits. This form of religion, where one person has the power to communicate with the spirits and tell his people what the wishes of these spirits are, is known as shamanism. And the leaders are shamans. So far we've been calling the powers that the shamans controlled spirit powers, but they have a fancier name. Look at the exhibit title again. Do you know what these powers are called? Animistic powers are what they are called. And the shamans controlled these animistic powers so that the people didn't feel quite so helpless or frightened by them. But what exactly are these animistic powers and what does animism mean? Look at case 1 - on your left. This tells us about the form of religion known as animism. What is animism? Animism is the belief that all substances, objects, and phenomena possess spirits. Look at the objects in the upper right of this case. Can you see some of the things believed to have spiritual powers? Some of the best examples shown here of objects having spiritual qualities are the sun, the moon, the wind, and thunder. According to animistic beliefs everything is spiritual, even mountains. Look at the Japanese shrine on the upper left. It shows a mountain which the people believed was a spirit mountain. Remember the Iroquois False Face Society? Like many other Indian tribes the Iroquois believed in many spirits, especially spirits of the forest like trees and animals, and spirits of nature like wind and thunder. The Iroquois religion, therefore, is based on the belief that all substances, objects, and phenomena possess spirits. What is this form of religion called? This belief that all substances, objects and phenomena possess spirits is known as animism. Therefore, the Iroquois False Face Society is animistic. According to animistic beliefs there are spirits in everything--both in good things like the sun and strength and in bad things like death. With all these spirits life could be pretty threatening and at times the people turned to shamans. How did the shamans help these people? The shamans told the people how to please the spirits. If the people pleased the spirits, the spirits would send rain or drive away sickness, or grant other wishes of the people. In this way animism helped the people to understand things in nature like rain and thunder and shamanism helped make them feel they had some control over these natural phenomena. They knew that if they were obedient and pleased the spirits, the spirits would be good to them.

This concludes your program on the Hall of Religion. Take your machine back to the attendant. Thank you very much for taking the program.

APPENDIX F

Following are sample questions from each of the four subject matter categories developed for use in the "recycling" machine (Figure 19). A total of 50 questions were developed for each category.

Only one category was used for the final floor test of the system (Table 7), viz., EVOLUTION.

HEREDITY

Chromosomes
   A. Contain genes
   B. Were discovered by Darwin
   C. Are always dominant
   D. Are always recessive

According to Darwin, all domestic chickens came from:
   A. Two basic strains
   B. The red jungle fowl
   C. Siberia
   D. United States

The exhibit uses which plant and animal forms to illustrate heredity?
   A. Witch hazel shrub and Irish Elk
   B. Roses and chickens
   C. Roses and dogs
   D. Flowering peas and cats

Mendel only discovered genes after he had
   A. Studied the Yokohama cock
   B. Studied eye color
   C. Cross-bred flowering peas
   D. Noticed blending of characteristics of roses

Genes were recently found
   A. To be absent in patients with cancer
   B. To contain nucleic acid
   C. To be lacking in the tobacco plant
   D. To be made up of chromosomes

ANIMAL AGE AND MOVEMENT

Of the following invertebrates, which has the shortest life span?
A. Ant
B. Snail
C. Sponge
D. Earthworm

Which animal can leap the farthest?
A. Puma
B. Whitetail deer
C. Horse
D. Impala

Over a distance of one mile, the proghorn antelope is ___ a mongolian gazelle.
A. Faster than
B. Slower than
C. Just as fast as

Which of the following animals has the greatest speed?
A. Greyhound
B. Pronghorn antelope
C. Cheetah
D. Horse

The age of a deer can be determined by its: ___
A. Antlers
B. "Points"
C. Teeth and bone structure
D. Hair length

EVOLUTION

New species of plants and animals arise largely as a result of
A. Spermatogenesis
B. Geographic isolation
C. Albinism
D. Hermaphroditism

DNA is found in the cells of
A. Microbes
B. Mold
C. Man
D. All of these

The scientific name for the fruit fly is
A. Drosphilia Melanogastner
B. ADN
C. Mus Musculus
D. Peromyscus Maniculatus

The principle of natural selection is credited to
A. Mendel
B. Darwin
C. Galileo
D. None of the above

Industrial melanism was effective in sustaining the pepper moth because
A. The moths developed larger wings
B. The industrial environment attracted them
C. Drosophilia appeared
D. Predation was minimized

SEED DISPERSAL

Birds aid in seed dispersal by
A. Burying nuts
B. Hitting plants and dispersing their seeds
C. Eating plant seeds
D. Ignoring seeds they do not like

Seed dispersal in palm trees
A. Occurs with wind dispersal of pollen
B. Involves hooks which carry them on animal fur
C. Involves seeds clinging to bird wings
D. None of these

Seed dispersal of the witch hazel shrub is
A. Wind dispersal
B. Mechanical dispersal
C. Floating dispersal
D. Accomplished only when squeezed between thumb and forefinger

Milkweed seeds are equipped with
A. Thick fibrous husks
B. An indigestible seed portion
C. Flossy silken "parachutes"
D. Clinging fruit

Mechanical dispersal is illustrated by the seed dispersal of
A. Palm trees
B. Squirrels carrying away nuts
C. Milkweed seeds
D. None of these

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